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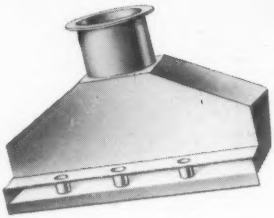

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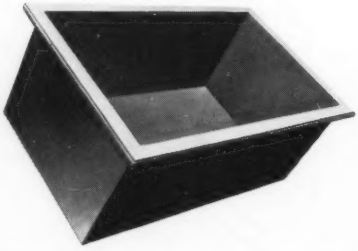

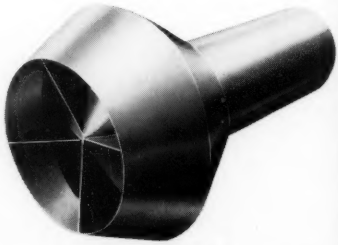

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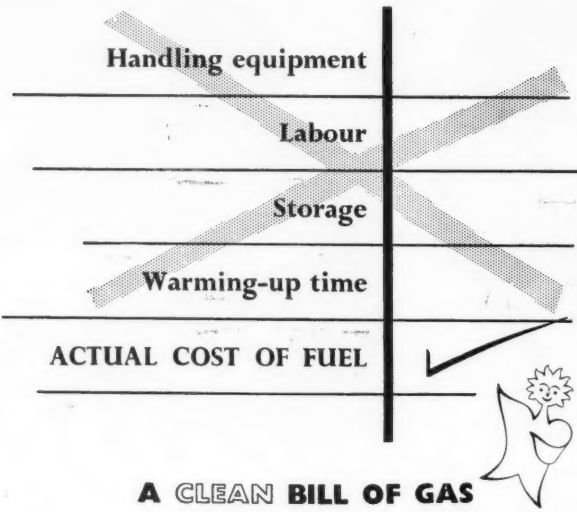

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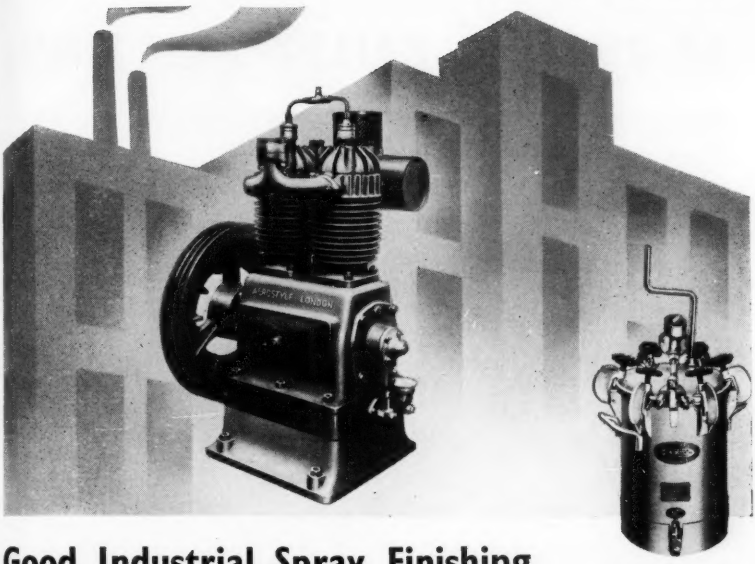

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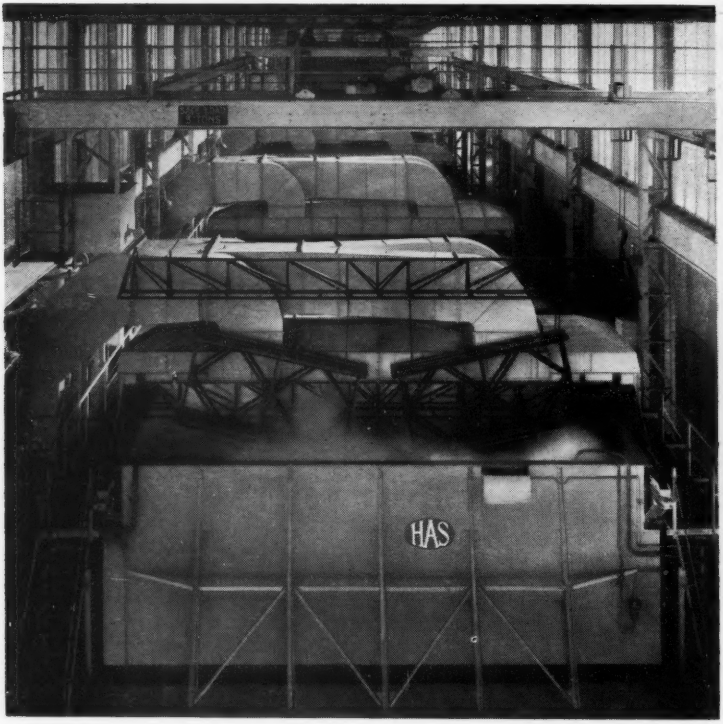

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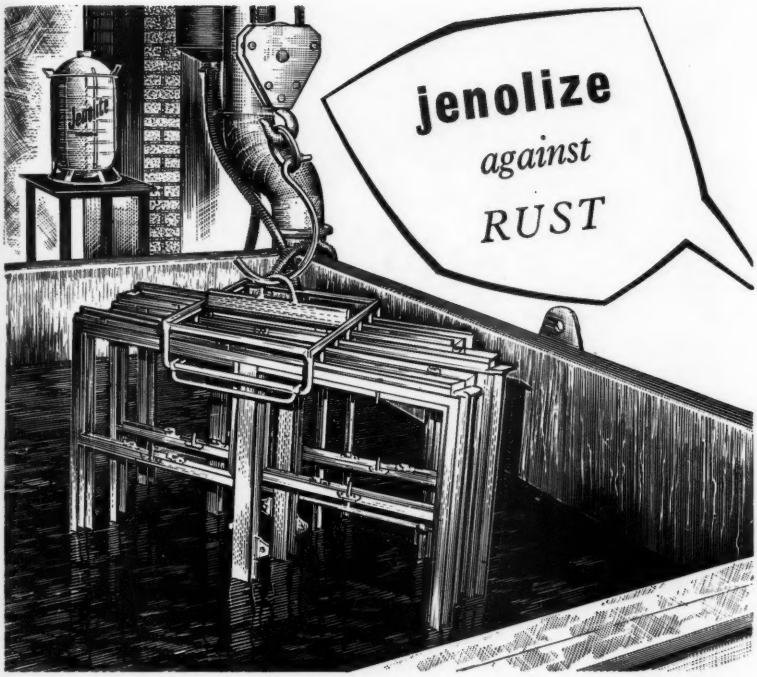

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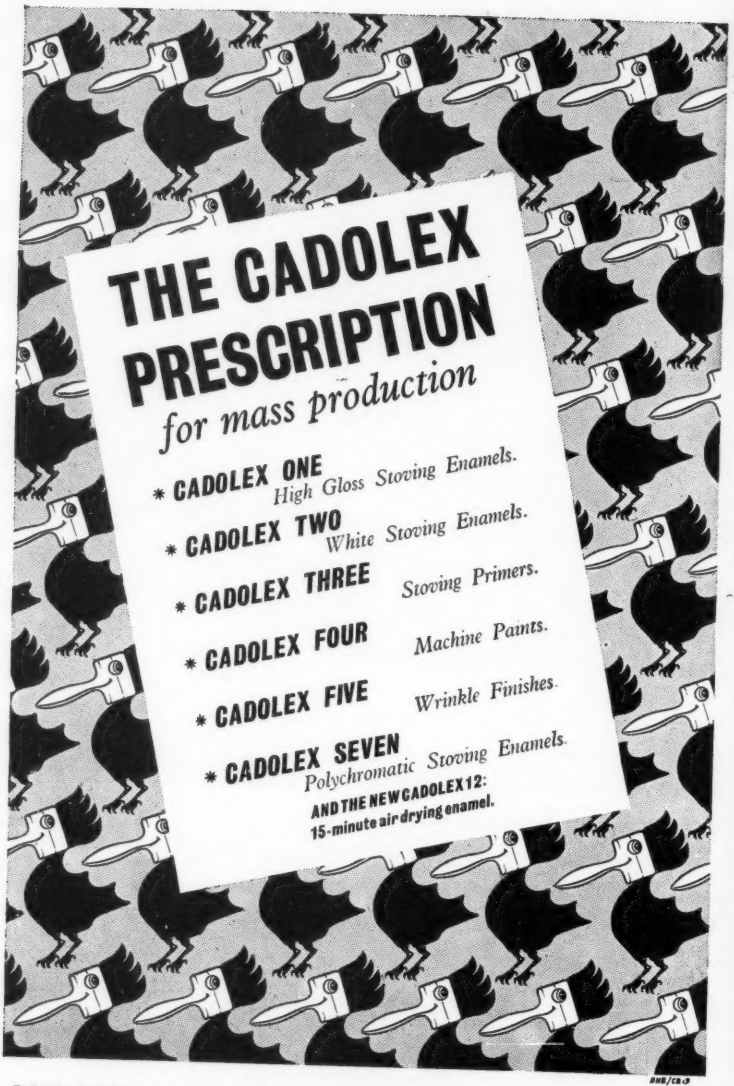
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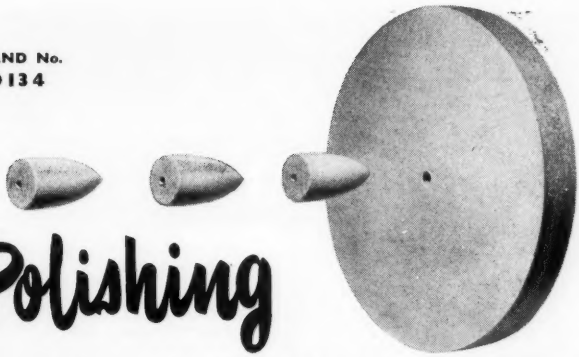

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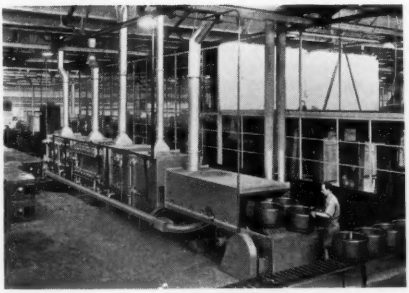

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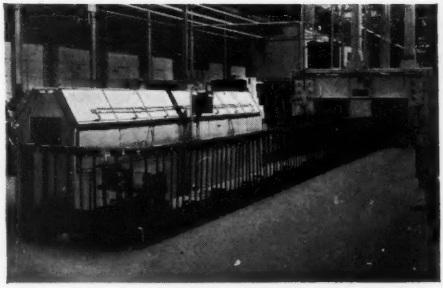

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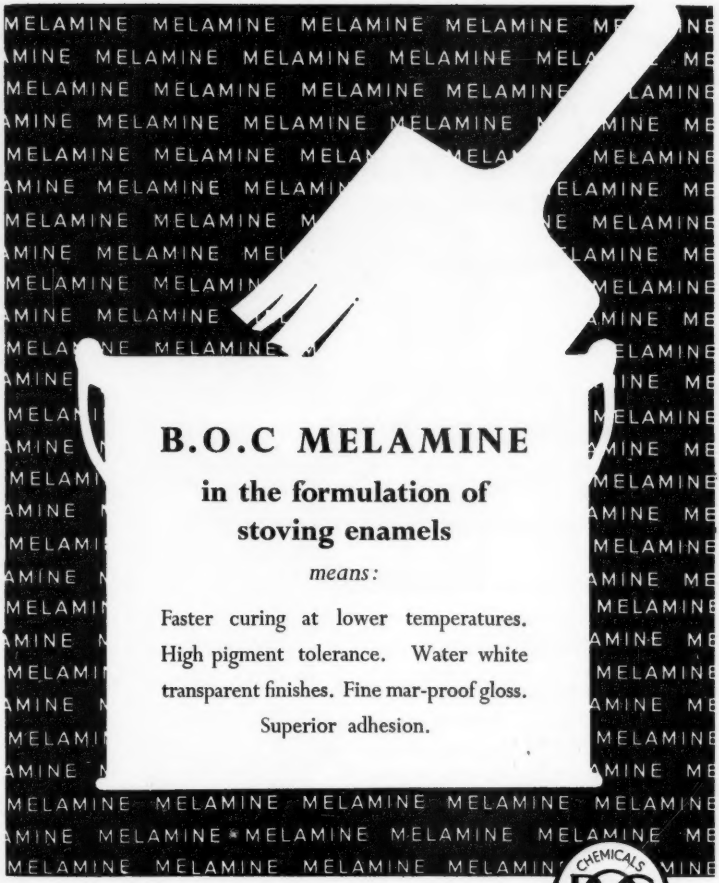

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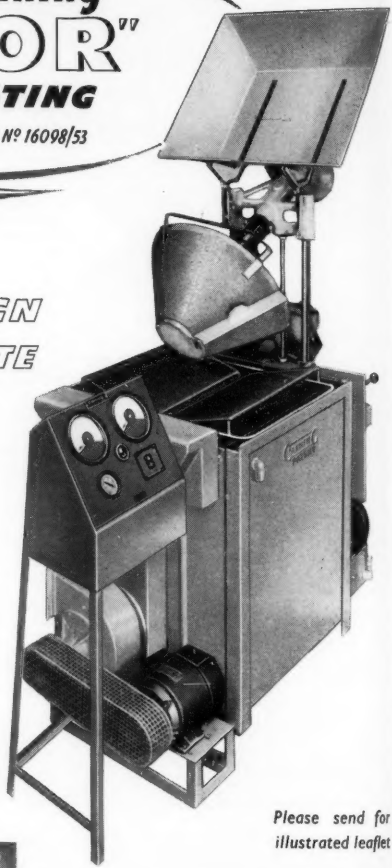

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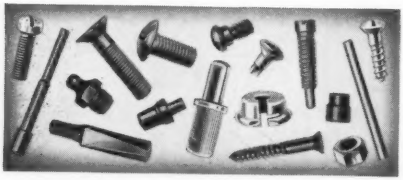

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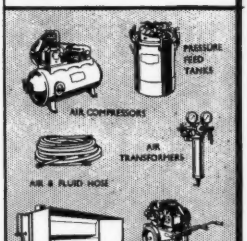

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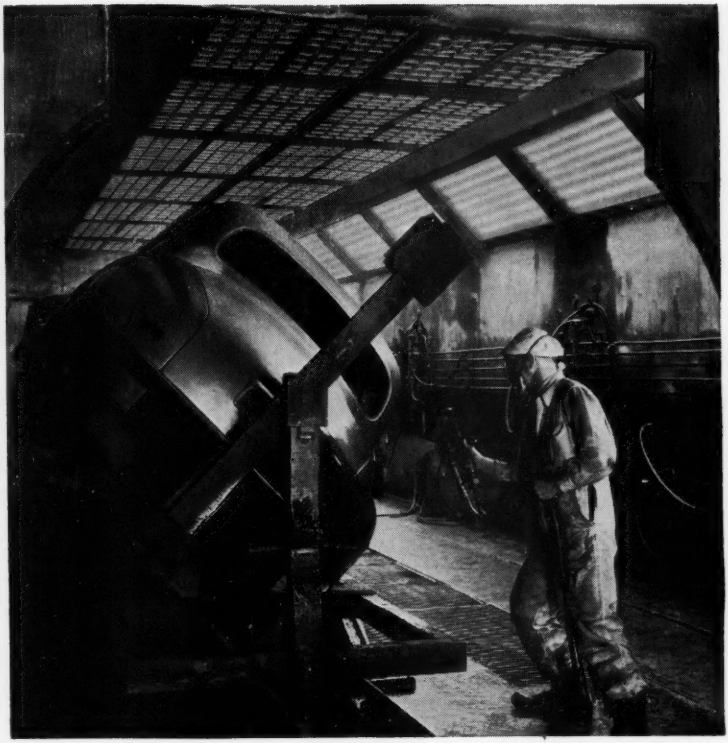

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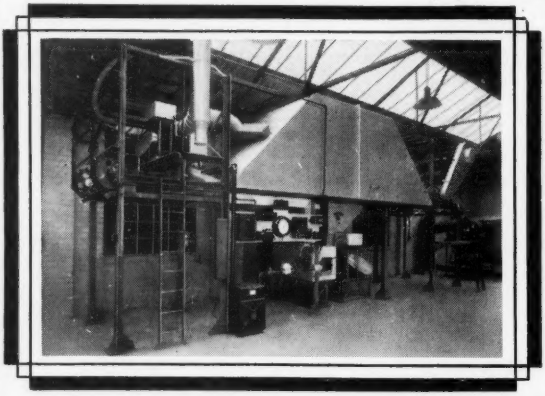

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Industrial Finishing

VOL. 6 APRIL, 1954 NO. 70

THE INTERNATIONAL CONFERENCE

AT the International Conference on Metal Finishing and Electrodeposition to be held in April, more than 400 delegates from Great Britain and from overseas will exchange views. A really comprehensive series of technical papers and social events has been arranged, and as a contribution to this the publishers of INDUSTRIAL FINISHING are distributing freely to all delegates a comprehensive "Buyer's Guide" outlining the sources of supply of finishing materials and plant in Great Britain, as well as a list of British trade and technical societies covering the finishing industries, with details of their officials and sphere of activities.

In the June issue of INDUSTRIAL FINISHING itself there will be a verbatim account of the discussion at the Conference with a résumé of the papers. Thus, the June issue will give a full pictorial account as well as an editorial survey of what is undoubtedly an important event for the finishing industries.

Fred May, the well-known cartoonist, will also be there and we feel sure that this special June issue will be a fine memento of an important occasion.

It so frequently happens with these special issues that after they are published the demand soon outstrips the supply and, of course, there is disappointment. So it is that early reservation of this June issue is advised.

What is more, this number should serve as an excellent medium for manufacturers to draw to their products the attention of those with a finishing interest.

IN the June issue of INDUSTRIAL FINISHING you will find a full report of the Conference discussions, photographs taken by INDUSTRIAL FINISHING and cartoon by Fred May of "Tatler" fame.

Low Temperature Enamels and their Application to Aluminium

(SPECIALLY CONTRIBUTED)

IN applying enamels to metals the lowering of the maturing temperature presents attractions in that:

(a) there is less danger of warping of the metal;
(b) the cost of heating is less;
(c) the possibility exists of applying vitreous enamel finishes to some non-ferrous metals of low melting point such as aluminium and some of its alloys which cannot at present be finished in this way.

There are certain difficulties, and it is true to say that all these have not yet been overcome, though research work is being pursued to this end.

The main trouble is that to produce very low melting enamels, such as required for aluminium, it is necessary to increase the fluxing materials and to introduce new ones. At the same time refractory materials must be reduced. It thus becomes difficult to maintain acid resistance, which is essential in modern cookers and other domestic appliances. Moreover, although lead oxide is a powerful flux and has been used in some formulæ for low temperature enamels, its use in this country is attended with considerable restrictions, to ensure the health of the operators. For this reason lead is avoided, except possibly in some jewellery enamels, and manufacturers would be very loathe to start using lead enamels.

Use of Lithium Compounds

Lithium compounds have been found to exert a powerful fluxing action, and their incorporation in glazes and enamels has made possible the lowering of the melting point. Other advantages claimed are improved gloss, acid and scratch resistance in the enamel, and improved fluidity at the melting point, so that holes in the enamel fill up more readily giving a smooth, bright, surface. As with the other alkali oxides Li_2O gives the enamel a higher expansion coefficient.

At the moment supplies of lithium compounds are difficult in this country. Lithium carbonate is the material commonly used, prepared from the natural ores lepidolite (lithium potassium aluminium fluosilicate) and spodumene (lithium, aluminium, silicate).

W. M. Fenton and D. A. Huppert (*Proc. Inst. Vit. Enam.* **9,** 84, 1947-50) have given a bibliography on the use of lithium compounds in enamels, and have also described experiments on using a number of lithium compounds in ground and cover coats. Lithium manganite, $Li_2O\ MnO_2$, and lithium cobaltite, $Li\ Co\ O_2$, could be used in place of manganese dioxide and cobalt oxide in ground coats, e.g., anhydrous borax 25·7 per cent., felspar 21·6 per cent., quartz 29·8 per cent., soda ash 9·2 per cent., sodium nitrate 5·1 per cent., fluorspar 6·2 per cent., lithium manganite 1·5 per cent., nickel oxide 0·6 per cent., lithium cobaltite 0·3 per cent.

The results indicate an increase in fluidity, which permitted a reduction of firing time and/or a lowering of temperature. The thickness of the applied coat could be lowered. There was improved adherence at lower temperatures, and under these conditions it was possible to use a lower grade of steel without blistering. Where it is not convenient to change the frit batch, the lithium compounds can be added at the mill. 1 per cent. lithium manganite lowered the melting point of some frits 30° F. to 70° F. Alternatively the addition of 0:5

College Station, Texas

per cent. to 0·75 per cent. made the enamel smoother and more easily worked at the same firing temperature.

In single coat acid resisting finishes 2 per cent. of lithium manganite added to the first batch lowered the firing temperature 50° F. Other lithium compounds useful in single coat finishes and ground coats are the cobaltite, silicate, titanate, zirconate, and lithium zirconium silicate. All the above except the silicate can also be used as mill additions. They reduce firing temperature, and also cut the firing time. In titania opacified cover coats the story was much the same. Obviously in white and similar finishes the manganite and cobaltite cannot be used. The silicate and titanate and lithium zirconium silicate were useful giving either shorter firing times, or reduced firing temperatures. This was achieved without loss of other properties.

Enamel Finishes on Aluminium and its Alloys

In a paper read at the 1950 Spring Meeting of the Institute of Vitreous Enamellers, R. P. Fraser, A. L. Chianchi and J. M. Cannor (*Proc. Inst. Vit. Enam.* **10,** 16, 1950-2) pointed out the enormous rise in the world production of aluminium. From a figure of 3,000 tons in 1935 it had risen to 1,250,000 tons in 1948. Of this total the U.S.A. contributed 46 per cent., Canada 27 per cent., U.S.S.R. 10 per cent. and France 5 per cent. Far and away the greatest consumer was the U.S.A. with 640,500 tons, with Great Britain next with 246,000 tons.

Being light and rust free, aluminium and its alloys have attractions as materials of construction, and their use has spread for domestic equipment as well as in aircraft, shipping and other forms of transport. At present the finishes available are various stoving enamels and dyed oxide coatings prepared by anodic oxidation. Neither of these will withstand heat without, at any rate, loss of colour. Attention has therefore been directed, especially in America, to developing enamel coverings for aluminium and its alloys.

The advantages claimed for enamelled aluminium are:

1. Excellent weathering properties;
2. Light weight;
3. Absence of corrosion if accidentally chipped;
4. It can be cut with a hacksaw for assembly.
5. High impact and thermal shock resistance.

Where enamelled panels are used for constructional work, and this is done in the U.S.A., though not as far as is known over here, these advantages are real, and possibly account for the commercial development of enamelled aluminium there. While development work has proceeded in this country, to date enamellers have shown no great interest in using aluminium in preference to steel for the kind of ware that is most in demand in this country.

Conditions to be Satisfied

In order that any enamel may adhere satisfactorily to aluminium and its alloys it must have a higher coefficient of expansion than those normally used on iron and steel. R. P. Fraser and co-workers (loc. cit.) give the expansion coefficient of aluminium and its alloys as $24-28\times10^{-6}$, while for iron and steel the values are $11-16\times10^{-6}$ over the range 0° C. to 600° C.

According to these authors the enamel for use on aluminium would require an expansion coefficient of $18-22\times10^{-6}$ as against $7{\cdot}7-11\times10^{-6}$ in iron enamels. Fortunately the enamels will also have to be very fusible and this helps in the problem of increasing the expansion characteristics. Moreover, the melting point of aluminium and its alloys is around 570° C. to 600° C. with an annealing temperature of 350° C. to 600° C. The melting point of the enamel would therefore have to be in the region of 500° C. to 550° C. as compared with temperatures ranging from 700° C. to 850° C. and higher for iron and steel enamels.

Adherence

Adherence is another factor to be considered. Very thorough cleaning treatment is required to enable good adhesion to be obtained with iron and steel. The preparation of aluminium for enamelling should not be more complicated and, if pretreatment of the metal could be simplified, so much the better. Finally the finish should

stand up to the usual wear and tear, and be resistant to the usual domestic scourers and fruit juice acids, etc.

Lead Enamels

The first process for enamelling aluminium employed enamels high in lead and alkalis, since this combination gave low melting enamels with high expansion. The original patent was taken out in 1917 (K. Warga U.S. Pat. 1230958 June 26, 1917; see also U.S. Pat. 1346475 May 27, 1919; Swiss Pat. 79,967, 85,577, 1919) but commercial application was not begun until comparatively recently.

The Dupont Patents (Brit. Pats. 580688 and 580689) give examples of the lead bearing type of frit (c.f. Vitreous Enamels, Borax Consolidated Ltd.).

	1.	2.
Boric acid	13·6	8·3
Silica	18·1	27·1
Titania	9·8	9·4
Soda ash	18·9	16·2
Lithium carbonate	—	5·7
Potassium carbonate	9·4	12·5
Red lead	30·2	20·8

To these may be added zirconia and antimony oxide and ceramic pigments. Colours available were red, brown, black, buff, white, and several yellows, blues and greens. The range of compositions of the finished coating covered by the patents was PbO 25 per cent. to 65 per cent., SiO_2 20 per cent. to 35 per cent., TiO_2 1 per cent. to 15 per cent., one or more of alkali oxides Na_2O, K_2O, Li_2O up to a total of 10 per cent. to 13 per cent. (Li_2O not more than 9 per cent.), possibly with additions of up to 10 per cent. B_2O_3, up to 7 per cent. ZiO_2, 0·5 per cent. to 5·0 per cent. Sb_2O_3, and 1 per cent. to 15 per cent. of colouring oxide (c.f. J. C. Bailey and M. E. Whitaker, *Light Metals*. **12,** 139, 1949). These enamels employed a ground coat under the coloured finishing coat.

Metal Preparation

These lead and titanium containing enamels needed special cleaning and preparation before enamelling. Details of a process were given in an article in *Ceramic Industry*, Jan. 1949. This involved degreasing in trichlorethylene vapour followed by chemical treatment. In this case the metal was treated with 6 per cent. sulphuric acid (with ½ per cent. wetting agent) at room temperature for 15 minutes. It was then treated with an alkaline bath made from: 0·02 lb. chromic sulphate, 1·00 lb. chromic acid, 1·19 lb. sodium hydroxide, 8·00 lb. water, for 4±1 minutes at 120° F.±5° F., followed by rinsing and drying.

This treatment was considered essential to form a good bond.

Lead containing enamels for aluminium have been produced in this country, but owing to patent protection titania has had to be omitted, and in the early formulations lithium compounds, which were expensive, were also left out. No preliminary surface treatment was required. The resistance to alkalis and water of the earlier types was poor, and in subsequent formulations this was corrected by alterations in composition at the expense of somewhat higher firing temperatures. Details of these are given by Fraser and co-workers (loc. cit.).

APPROX. MOLAR PERCENTAGE OF LEAD-BEARING ENAMELS FOR ALUMINIUM.

	*Aluglas**†	*A*	*B*	*B*.1
PbO		40-50	25-35	10-20
SiO_2		20-30	30-40	40-50
Li_2O		0-1	0-3	0-3
Other alkalis R_2O		5-7	9-12	12-16
B_2O_3		15-20	10-15	8-10
Al_2O_3 ...		1-3	1-3	2-4

**"Aluglas" A, B, and B.*1. *Brit. Pat. Application No.* 37,078, 1946. †*"Aluglas" is the trade-mark of Amalgamated Research and Development Co. Ltd., for their frits.*

These were opacified by molybdenum compounds. Ammonium molybdate was added to the batch and ammonium, sodium and calcium molybdates were added in addition to the mill batch. Zircon can also be added at the mill (Brit. Pat. Application No. 14,774, 1948).

Experiments with lead bearing enamels seem to indicate that simple cleaning is sufficient to ensure a good bond, the aluminium oxide film promoting good adherence (Bailey and Whitaker, loc. cit.). With certain types of lead-containing enamels it appears to be the practice to use metal pretreatment as an insurance in production in the manner outlined above.

Pickling of castings in caustic soda is recommended to remove surface skin, which does not give good adhesion.

Leadless Enamels

Lead enamels suffer from the disadvantages that:

(a) lead is poisonous and this limits the application of such enamels. Moreover, factories employing lead compounds must conform to strict regulations designed to protect work people;
(b) their resistance to chemical attack is limited;
(c) stability of colours varies and special frits must be used for certain colours;
(d) certain alloys cannot be enamelled with existing frits;
(e) In some cases metal preparation must be done before enamelling.

Successful attempts have therefore been made to evolve leadless enamels suitable for aluminium and its alloys.

These have proceeded along two lines. In one type of frit produced in this country ("Aluglas D") the lead oxide has been replaced with oxides of the alkaline earth metals, while maintaining the possibility by the use of alkali metal oxide (including lithia) and boric oxide. These "Aluglas" frits can be applied direct to commercial sheet aluminium and a number of the more important wrought and cast alloys.

In those alloys with fairly large percentages of copper and magnesium special undercoats are employed to promote adhesion. Development work is still proceeding in this field.

Low Temperature Phosphate Enamels

The other type of development is the use of phosphate enamels. Development of this has proceeded in this country and in the U.S.A.

Early attempts at leadless enamels were based on silicate-borate glasses and in many cases the maturing temperature was too high. J. W. Donahey, G. J. Morris and B. J. Sweo have described phosphate base glasses as enamels for aluminium (*International Enamellist* **1**. [4]. 6. 1951).

The compositional limits are defined by a formula:

$$\left.\begin{matrix}0{\cdot}5\ Na_2O\\0{\cdot}5\ Li_2O\end{matrix}\right\} \times Al_2O_3 \left\{\begin{matrix}y\ B_2O_3\\z\ P_2O_5\end{matrix}\right.$$

in which $x+y+z \geq 2{\cdot}0$ approx.
x does not greatly exceed z
(x+y) does not greatly exceed 2z.

The following was used as a base for Al enamel compositions:

1.

$$\left.\begin{matrix}0{\cdot}25\ Li_2O\\0{\cdot}55\ Na_2O\\0{\cdot}2\ Na_2F_2\end{matrix}\right\} 0{\cdot}417\ Al_2O_3 \left\{\begin{matrix}0{\cdot}625\ P_2O_5\\0{\cdot}208\ B_2O_3\end{matrix}\right.$$

By itself this gave severe boiling due to reaction of frit with the aluminium. This was overcome by using a ground coat of:

2.

$$\left.\begin{matrix}0{\cdot}2\ Li_2O\\0{\cdot}2\ Na_2F_2\\0{\cdot}4\ Na_2O\\0{\cdot}2\ CuO\end{matrix}\right\} 0{\cdot}417\ Al_2O_3 \left\{\begin{matrix}0{\cdot}625\ P_2O_5\\0{\cdot}208\ B_2O_3\end{matrix}\right.$$

The application of a ground coat required preliminary cleaning and etching. An alkaline or acid bath at 220° F. gave satisfactory results. It contained tetra sodium pyrophosphate, sodium sesquicarbonate, and wetting agents. Three minutes immersion at 220° F. gave a clean etched surface. The acid bath recommended contained 5 per cent. sulphuric acid and the metal was immersed in it for 5 minutes at 220° F. followed by the usual washings. Large castings were degreased by firing to 900° F. and then sandblasted.

Clay Unsuitable for Suspension

Clays are unsuitable for suspending the frit as their presence increases the maturing temperature and the result is a poor immature enamel at the required firing temperature. Donahey, Morris and Sweo recommended sodium silicate as a suspending medium, and give a typical mill batch as follows:

100 frit (by weight)
2 sodium silicate (by vol.)
½ sod. tetraphosphate (by weight)
35 water (by weight)

The ground coat mentioned above was applied in one application at approximately 30 grams per square foot of surface (dry weight). Its colour is a transparent blue-green.

All cover coats were based on the composition (1) above. Opacifiers were added at the mill and 10 per cent. titania additions gave a white with 75 per cent. reflectance. For cover coats the sodium tetraphosphate was replaced by the same amount of potassium chloride for set up agent. The usual colouring oxides could also be added.

The phosphate enamels resisted scratching by a penknife. Acid resistance was satisfactory for most indoor applications. At present an improvement in resistance to weathering is desirable and this angle is being followed up. Laboratory tests indicated that the alloy used has little effect on the properties of phosphate enamels.

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I.C.I. TO MAKE NEW PLASTIC MATERIALS

IMPERIAL CHEMICAL INDUSTRIES Ltd. have plans for the first large-scale production in Great Britain of a range of rubber-like polymers based on butadiene. Pilot plant quantities should be available later this year, but it is not expected that the full-scale plant at Wilton, North Yorkshire—which will have a planned capacity of about 10,000 tons per year—will commence operation before 1956.

Using butadiene produced in I.C.I.'s oil cracker at Wilton, it is intended to manufacture copolymers using a variety of second components, including acrylonitrile and styrene. These copolymers will cover a range from oil-resisting substances of the Perbunan type to hard, reinforced resins. The resins will be particularly attractive for use in shoe-soling compositions, and they will also be available in the form of latices suitable for the production of emulsion paints.

Some of the polymers it is proposed to manufacture will be similar to those already being made in the United States, but others will be novel, both in composition and in properties. They will all be speciality materials designed to provide effects which at the present time can only be achieved by restricted imports from the United States.

I.C.I.'s Plastics Division, with headquarters at Welwyn Garden City, will be responsible for polymer production, development and sales, using raw materials obtained mostly from other Divisions of the Company.

THE INSTITUTE OF WELDING

THE Spring Meeting of the Institute will take place this year from the 28th April to the 1st May in South Wales and Bristol. The following papers are to be presented: "Steelmaking and Welding," Dr. R. L. Reeve; "Hydrogen—Barrier to Welding Progress," Dr. C. L. M. Cottrell; 29th April at Porthcawl. "Nitrogen Arc Welding of Copper," E. Davis; "Nitrogen Arc Welding of Copper," Dr. K. Winterton; 30th April at the Grand Hotel, Bristol. "Welding in the Aero Engine Industry—Reflections on Organisation by a Production Engineer," F. G. C. Sandiford; "Welding as a Career," F. Koenigsberger; 1st May at the Grand Hotel, Bristol.

Sealing Metal Surfaces with Resins

by A. E. WILLIAMS, Ph.D., F.C.S.

A NEW group of synthetic materials, the ethoxyline resins, is providing the answer to many production problems where the protection and sealing of metal surfaces is involved. Some of the light metals and their alloys already possess good resistance to corrosion, for example, the film of oxide which forms on an aluminium surface serves to protect the metal under ordinary conditions; but the film which forms on magnesium, however, does not offer the same degree of protection. Where either magnesium or aluminium are associated with copper in an alloy, the tendency to corrosion is increased.

The uses of ethoxyline resins are not confined to the coating of light metals, they have been applied successfully to bronze, ferrous metals, etc. When the components after manufacture have to be painted, a preliminary coating of resin on the metal has advantages. As is well known, before a coat of oil paint can be applied successfully to the metal surface it is necessary to prime or otherwise treat the surface to form a key for the paint. When a coat of resin is applied, however, the only preliminary treatment necessary is the usual degreasing in trichlorethylene or other solvent.

Ethoxyline resins were first developed in Switzerland, by Ciba Ltd., and are now in full-scale production at the Duxford factory of Aero Research Ltd., being marketed under the trade name of "Araldite." The resin employed for coating metals is a thermo-setting, oil-free product in the form of a solution for use with a mixture of solvents. It consists of two compounds, known as C1 and C3, which are mixed together in the proportions of 1 part to 3 parts by weight respectively, and then diluted in mixtures of solvents formulated according to the purpose for which the resin is required. Application of the solution to the surfaces to be treated may be by dipping, spraying or roller coating.

The resin is compatible with most pigments, or it may be dyed to give transparent coloured coatings.

Compared with the conventional oil-based lacquers, the resin has several advantages. In the first place, its adhesion to metal is quite exceptional and as a matter of fact this group was originally developed as an adhesive for light alloys; in which application it is still very successful. The product used for coatings is a modified form of the original adhesive resins and thus gives unequalled adhesion to metal surfaces. Secondly, the resin coatings combine in a high degree the properties of hardness and flexibility; neither characteristic being achieved at the expense of the other. The coatings are smooth, hard, resistant to abrasion, and very flexible. Finally, the resin coating offers excellent resistance to chemicals, foodstuffs, and most common solvents, as well as to conditions of exposure in which heat and humidity may be encountered.

Chemical Resistance

Tests have shown that the following chemicals have no effect for at least thirty days upon metal panels, stoved at 180° C. for one hour, which have received a single coating of the resin: concentrated hydrochloric acid, 10 per cent. acetic acid, 40 per cent. sulphuric acid, 10 per cent. phosphoric acid, 5 per cent. formic acid, concentrated caustic soda solution, concentrated ammonia solution, 10 per cent. sodium hypochlorite solution, and concentrated potassium hydroxide solution.

Fig. 1 shows some of these tests after periods up to seven days, depicting an aluminium panel treated with the resin then coated with various

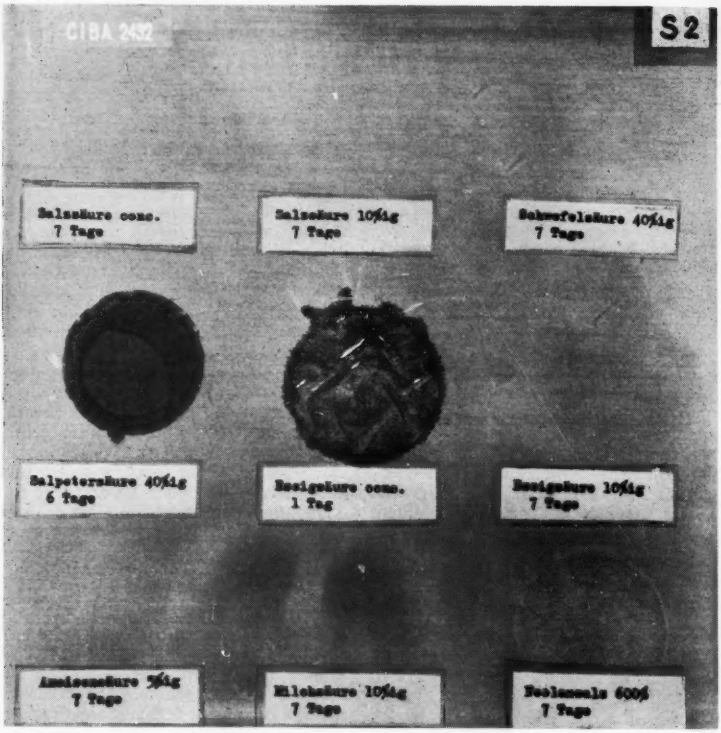


Fig. 1. Aluminium panel treated with ethoxyline resin, then coated with various acids in circular areas. Only nitric acid and glacial acetic acid produce any marked effect. (Ciba Ltd.)

acids in circular areas; only nitric acid and glacial acetic acid produce any marked effect. Other tests have demonstrated that coated panels are resistant to 60 per cent. potassium hydroxide and to 60 per cent. sulphuric acid for at least five hours at a temperature of 80° C. Coated aluminium rods have also been immersed in 20 per cent. hydrochloric acid, 50 per cent. lactic acid, 30 per cent. caustic soda solution, and strong ammonia solution for more than one year without signs of deterioration.

In Fig. 2 are seen three aluminium rods immersed in 5 per cent. caustic soda solution; the rod on the left and the upper part of the centre rod were left untreated, while the rod on the right and the lower part of the centre rod were coated with the resin. Bubbles rising from the untreated surfaces show the effect of caustic soda solution on the unprotected metal; the coated surfaces are not attacked.

The same type of coating exhibits excellent resistance to benzene, toluene, xylene, butanol, methanol, ethyl acetate, ethylene dichloride, petroleum, naphtha, tetralin, turpentine, and white spirit. As far as foodstuffs and beverages are concerned, good resistance is offered to beer, wines, spirits, mustard, tomato puree, and certain fruit juices, but not to pineapple juice.

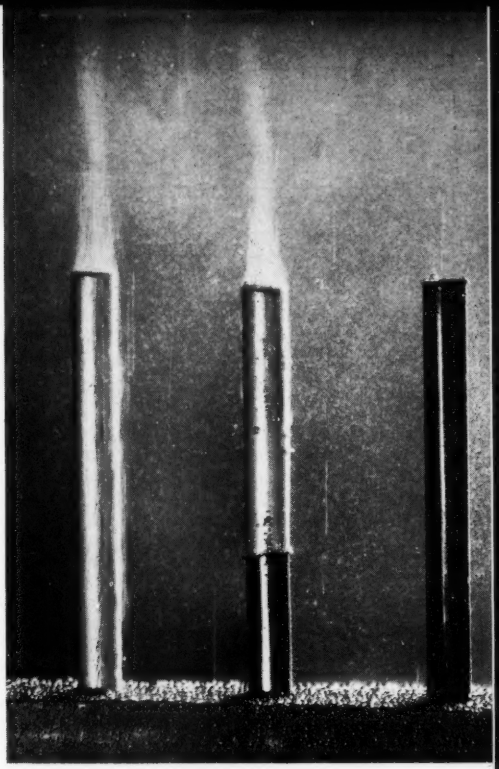


Fig. 2. Three aluminium rods were immersed in 5 per cent. solution of caustic soda. The rod on the left and upper part of centre rod were left untreated, while the rod on the right and lower part of the centre rod were coated with ethoxyline resin. Bubbles rising from the untreated surfaces show the effect of the caustic soda on the unprotected metal; the coated surfaces were not attacked. (Aero Research Ltd.)

In a series of "tropical" tests, panels which had received four coatings of the resin were not affected by exposure for six weeks at temperatures varying from 20° C. to 35° C., with a relative humidity of 95 per cent.; nor were they impaired by repeated spraying of salt water solution on them at a relative humidity of from 60 per cent. to 80 per cent. At room temperature, the resin coatings were unimpaired at the end of one year's immersion in water. For good resistance to boiling water, it is advisable to apply several coats of resin.

Tests carried out by a public analyst show that the resin, when used with suitable solvents, has no effect whatsoever upon the flavour of foodstuffs. It has been further demonstrated that the coatings offer a high resistance to the acids occurring in certain types of foodstuffs, and this fact is of particular interest to manufacturers of containers, including collapsible tubes, for foodstuffs.

Physical Properties

The most outstanding physical characteristic of the resin—adhesion to metals—has been demonstrated convincingly by coating two aluminium alloy strips with the resin and then bonding them together to form a $\frac{1}{2}$ in. lap joint by using another resin of the group as an adhesive. The loading required to separate the two strips was measured in shear in a tensile testing machine, and an average load of 3,200 lb. per sq. in. was needed to separate the bonded surfaces, at which figure the surface coating generally parted from the metal.

The hardness of the resin used for coating is indicated by the following results in "Sward" units, the figure 100

being the maximum value and signifying the hardness of plate glass.

HARDNESS OF ETHOXYLINE COATING RESIN, IN SWARD UNITS.

Time (*min.*)	*Temperature ° C.*			
	160	180	200	220
20	80	80	77	82
40	82	81	78	84
80	82	81	86	88
160	84	88	88	88

It will be noted that the degree of hardness obtained is only slightly affected by stoving conditions.

The flexibility of the resin coating has been tested according to Erichsen's method, and the following table shows the colour of film and distensibility under different conditions of stoving.

Selection of the appropriate curing time and temperature enables any desired coating within the range colourless—brownish yellow to be obtained. As the coatings are not easily over-cured, several coats may be applied without risk of producing brittle undercoats. The highest degree of chemical resistance is provided by coatings that are cured to a light yellow or gold colour. Number of coatings to be applied will vary with the job in hand, and often a single coating is enough. Further coats when required may be based either upon the resin or upon conventional types of finish.

The flow, gloss, and "build" of syn-

RESULTS OF DIFFERENT STOVING CONDITIONS.

Temperature ° C.	*Time in min.*	*Colour of Film.*	*Distensibility in mm. (Erichsen's test)*
160	20	Colourless	0·5
160	40	Colourless	8·8
160	80	Colourless	9·2
160	160	Colourless	9·4
180	20	Colourless	8·8
180	40	Colourless	8·8
180	80	Light Yellow	9·0
180	160	Light Yellow	9·2
200	20	Colourless	8·8
200	40	Light Yellow	8·8
200	80	Golden Yellow	9·3
200	160	Golden Yellow	9·4
220	20	Light Yellow	9·0
220	40	Golden Yellow	9·0
220	80	Golden Yellow	9·4
220	160	Brownish Yellow	9·4
360	1	Golden Yellow	9·4

thetic stoving enamels of the urea-alkyd type are greatly improved if they are applied after a first coating of the resin. Moreover, the chemical resistance of the stoving enamels is improved when they are used over the resin undercoat of their own conventional primers.

In another test to ascertain the flexibility of an applied coating of ethoxyline resin, a resin-coated circular sheet of metal approximately 0·025 in. thick and 1 in. in diameter was subjected to spherical pressure causing a depth of distortion of 0·04 in. This figure corresponds to a flexibility of about 20 per cent. in the coating, which is a very good result when it is considered that hardness is an equally outstanding characteristic, and that the stoving schedules required for maximum chemical resistance do not militate against hardness and flexibility.

Method of Use

The ethoxyline resin is supplied in the form of two separate components which, at temperatures not exceeding 40° C., have a shelf life of at least one year. The two components are first mixed in the proportions of 1 part to 3 parts by weight respectively, and this mixture gives a neutral resin of about 50 per cent. solids content. Before use it is allowed to stand for at least twenty-four hours, and in this mixed condition it has a shelf life up to four months at normal temperatures; but dilution with solvents increases the shelf life. The solvents used include acetates, ketones, glycol ethers, alcohols and aromatic hydrocarbons; but aliphatic hydrocarbons are not used. The formulation of solvent mixtures depends upon the method by which the coating is to be applied, by dipping (which is generally the most satisfactory technique), by rollers, or by spraying.

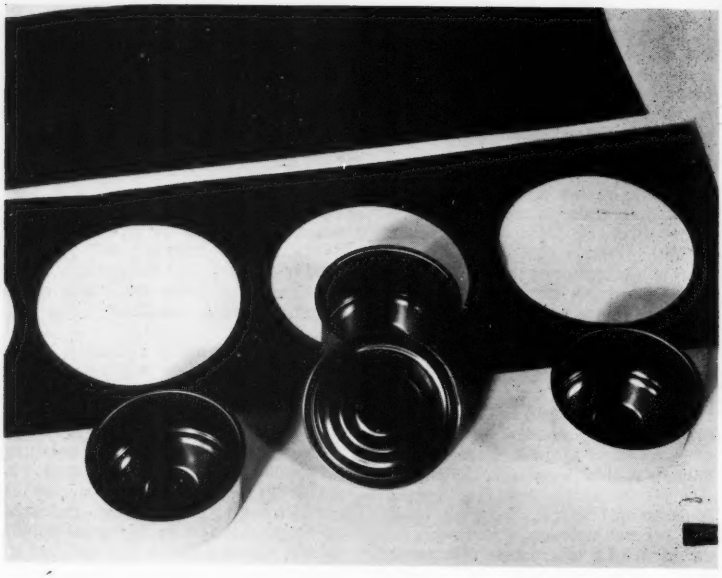
The number of good formulations can be reckoned in hundreds and the following three examples are given only as general indications which may help to determine the mixture most suitable for a specific purpose. For application by dipping: 500 parts by weight of the resin, 150 ethyl acetate, 180 diacetone alcohol or ethyl glycol, and 170 parts by weight of toluene. For application by rubber roller: 555 parts by weight of resin, 385 diacetone alcohol, and 60 parts by weight of methyl ethyl ketone.

When a steel roller is used for the application, the mixture becomes: 523 parts by weight of resin, 82 diacetone alcohol, 360 methyl acetate or ethyl acetate, and 35 parts by weight of toluene. If a gelatine roller is employed, a satisfactory mixture is: 700 parts by weight of resin, 70 diacetone alcohol, 115 tetraline, and 115 parts by weight of xylene. A typical spraying mixture is as follows: 400 parts by weight of resin, 300 diacetone alcohol, 150 toluene or xylol, and 150 parts by weight of ethyl acetate or butyl acetate.

It is not normally necessary to use a plasticiser in the mix because the resin is already sufficiently flexible. The resin may be pigmented, but strongly basic pigments may gradually increase the viscosity of the mixture, with a corresponding decrease in usable life. The resin may also be dyed to give transparent coloured coatings, the dye being added to the solvent mixture before the addition of the resin. To obtain a high quality finish, filtering of the solution is desirable. When dyes are used with the resin, a stoving temperature between 160° C. and 170° C. is commonly employed in order to obviate as far as possible any discoloration produced in the cured resin. The resin is compatible with a number of other materials used for coating purposes. It can be mixed, for example, with certain urea, melamine and phenolic resins, as well as with alkyd resins of low fatty acid content.

Some Applications

Although the ethoxyline resin may be used on numerous metals, its exceptional adhesion to aluminium and magnesium alloys, and the increasing amounts of light metals used in industry, suggest that it is in the surface protection of light alloys that the resin will find its principal applications. Often the resin is used as a primer to improve the performance of subsequent coatings of a conventional type of finish, while its combined properties of hardness, flexibility, adhesion and chemical resistance have resulted in its adoption for the protection of metal surfaces whenever severe conditions of use will be encountered. The resin is, therefore, of interest to



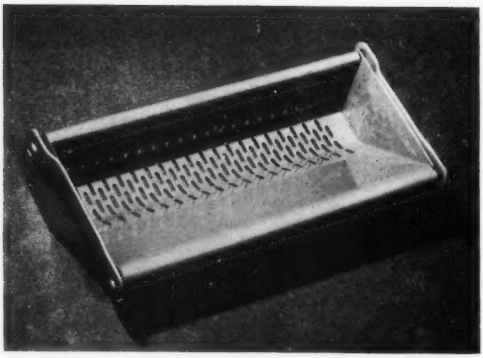


Fig. 3. (*Above*) *Light alloy sheets coated with ethoxyline resin can be deep drawn to produce food containers without damaging the coating.* (*Aero Research Ltd.*)

Fig. 4. (*Left*) *Elevator food bucket coated with ethoxyline resin by Loyne Ltd.* (*Mather & Platt Ltd.*)

manufacturers of industrial equipment.

Foodstuffs, beverages, cosmetics and pharmaceutical products are supplied in containers which, by virtue of the flexibility of the coating, can be deep drawn from metal sheets previously roller-coated in the flat condition; an example of this can be seen in Fig 3. Similar products are packed in collapsible tubes and here again such properties as flexibility, non-toxicity, adhesion and chemical resistance combined in one resin are of value.

The coating of food machinery, trays and buckets for conveying foodstuffs (Fig. 4), the protection of refrigerators and domestic equipment are other applications in which the resin is proving of value. Good dielectric properties have enabled coatings to be used for electrical components operating at high temperatures, and a

Fig. 5. Magnesium alloy aircraft components coated with ethoxyline resin stoving lacquer. (Gittings & Hills Ltd.)

modified form of the resin has proved suitable for the manufacture of wire enamels.

A high degree of chemical resistance has led to the use of the resin for chemical engineering plant, drying trays, paddles, storage tanks, and the inside surfaces of pipes; also for the protection of equipment used in dairies, breweries and the textile industry. Components used in aircraft manufacture (Fig. 5) are coated with the resin to give protection against weather and prevent corrosion.

Costs

At first sight the cost of the resin coatings is high when compared with that of some other types of finish. The area covered by unit volume is, however, far greater. The thickness of the resin coating varies between 0·0005 in. and 0·0008 in. and with thin films a higher degree of protection is obtained than with thicker coatings of conventional finishes. The amount required to cover a given area varies according to the method of application, but the following figures for one gallon of the resin and solvent mixture are typical: By dipping, from 900 sq. ft. per gal., to 1,000 sq. ft. per gal.; by spraying, 600 sq. ft. per gal.

One manufacturer has reported that light alloy castings coated by a mass production technique proved less costly than when they were treated with conventional and apparently less expensive finishes. Thus, a lighter and efficient coating was obtained at reduced cost. Even very thin films of the resin give improved performance and total weight additions can be as low as 0·3 oz. per sq. yd. for a single coat, or 1·75 oz. per sq. yd. for a multi-coat system of pigmented finishes. It is probably true to say that the potential applications of the resin exceed in number the uses to which it has so far been put; its properties make possible the development of better components.

The Lille International Trade Fair.—The Lille International Trade Fair will take place this year from the 1st-16th May. A technical and economic display open to industries all over the world, the Fair has annually about 3,500 exhibitors of some fifteen different nationalities. One-and-a-half million visitors are admitted annually. Many countries allow special facilities and reduced travel rates on production of the "Faire Identity Card," issued by the Fair authorities, French Consulates and principal travel agencies.

RECENT DEVELOPMENTS

MATERIALS : PROCESSES : EQUIPMENT

"CHLORO-FLASH" EXTINGUISHER

"CHLORO-FLASH" is the registered trade-mark of Nu-Swift Ltd., Elland, Yorks. It is a new pressure-operated extinguisher charged with chlorobromomethane and carbon dioxide. At the source of the fire the former gasifies quickly for it produces a fire inhibiting gas at low concentration.

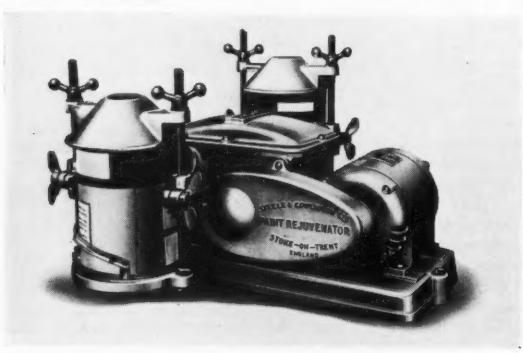
It is a product of World War II but was not then made on a commercial basis. It is claimed to be much superior to carbon tetrachloride. What is more, it is also claimed that when used under pressure the new "Chloro-flash" extinguisher will put out a fire in $1\frac{3}{8}$ sec. which a hand pump would take over 40 sec. to put out.

REJUVENATING STORED PAINT

THE longer paint is stored in tins, the more difficult becomes the task of preparing it for use. The re-mixing of stiff sediments by hand, often requiring the addition of thinners, has in the past been the obvious and only available method. Paint stockists and industrial users will readily agree that this method is most unsatisfactory. Obvious disadvantages are the unavoidable waste of time in opening, stirring, and closing the cans; the constant risk of contamination from dirt, skinning, etc; the fact that if thinners are added they might not be suitable to dilute the manufacturer's formulation; and finally, of course, the waste of the stiff sediment which is bound to be left in the cans.

These problems have been solved by a paint rejuvenating or shaking machine, which will recondition small cans of paint from one pint to one gallon in a matter of minutes, no matter how long they have been in store. The cans are simply clamped upside down and unopened in the quick release adjustable holders of the machine, and subjected to violent mechanical agitation which speedily restores the paint without any loss of its original qualities.

The manufacturers, Steele and Cowlishaw Ltd., Hanley, Stoke-on-Trent, make models of varying sizes up to those capable of taking twelve 5-gal. drums.



A PLASTIC CAR BODY

SATISFACTORY tests of a fibreglass-bodied car have been reported from America. The car, called the Alembic I, has a body made of Vibrin fibreglass. It consisted of one Vibrin 114 shell (overlay) coat, and four Vibrin 114 bonded layers of fibreglass mat and cloth alternately. It was painted with ordinary lacquer. The car was tested in all conditions over a series of trips totalling 28,000 miles altogether.

The following conclusions were drawn from the tests: The body has sufficient strength to survive minor accidents without major repair costs, will not dent, rust or lose paint adhesion. It will operate satisfactorily within a

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wider temperature range than 10°-140° F., has a good dimensional stability in wet and dry conditions with fatigue resistance to absorb normal body torque. The body can be satisfactorily attached to metal or other framing by adhesive or bracket embedment methods and will not surface crack in normal service.

Dr E. S. Ebers of Naugatuck Chemical, U.S.A., who carried out the testing, predicts a great future for fibreglass in the automotive industry.

POWDER-TYPE HAND CLEANSER

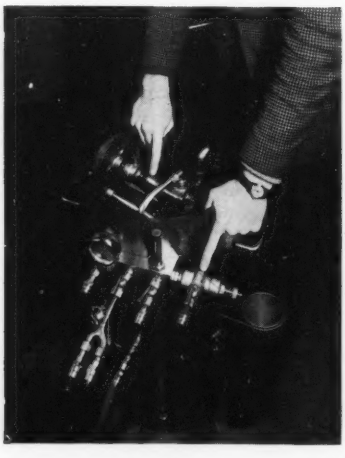
A POWDER-TYPE hand cleanser, designed for use in industry, will be demonstrated at the British Industries Fair, on Stand No. D.718 at Castle Bromwich, by Borax Consolidated Ltd. Known as Boraxo (Braxo), the cleanser removes grease, grime and chemicals from workers' hands.

Boraxo is used from a vitreous-enamelled steel dispenser, a few taps of the plunger providing enough powder for each wash.

TWO GUN HOT SPRAY UNIT

IN our February issue we mentioned the Atlas Diesel Co.'s Ecco H3B hot-spray unit, the two guns of which can be used independently without impairing the continuous performance of either.

Our illustration shows the composition of the unit. It consists of three main sections. The upper section includes the paint pump, the two-gun adaptor unit and thermometer and gauge for controlling the temperature and pressure of the paint. The intermediate section contains a one-phase 3,500-watt element, and a manually operated thermostat with signal lamp. The water section is the lower section. It includes the vessel in which the elements, the paint coil and the pipe from the thermostat are suspended with a water funnel, a water level indicator pipe and a drain cock.



ANTI-RUST PRODUCTS

IN the comprehensive range of industrial oils exhibited on Stand D.510 at the B.I.F. by Fletcher Miller Ltd., of Hyde, Cheshire, are several interesting anti-rust products.

Prominent amongst them is "Flick" Easing Oil, a fluid for releasing rust-seized parts. It also frees in a matter of minutes parts bound by corrosion, fire, acid, burnt oil or red lead without the danger of stripping threads, breakage or damaged surfaces.

Also displayed is the well-known range of "Rodol" Rust Preventives which covers practically every aspect of temporary rust prevention, giving protection for a few hours or over six months, according to the grade used.

Grease removal as a production process also receives special attention, for there are "Solvex" crystals for hot water degreasing and "Liquid Solvex" for cold water cleaning of metals.

AIR COMPRESSORS

H.E.C. COMPRESSORS AND ENGINES LTD. will be showing on their stand, No. D.739, a range of their compressors. One new model will be on display—Model 40, a single-cylinder 4 in. × 4 in. compressor of 21·5 c. ft. per min. displacement, suitable for blow-gun and paint spraying use.

NEW TYPE GUN FILTER

B.E.N. PATENTS LTD., High Wycombe, have produced a paint strainer, the "Freeflow," for use with all types of syphon feed and internal mix pressure feed spray guns with material tubes of $\frac{3}{8}$ in. outside diameter. Made from a fine mesh brass screen, the "Freeflow" has been found in tests to have

eliminated clogging and spitting. Even with skin present in the paint the speed of coverage was not affected, nor did any skin pass the strainer.

COPPER AND ALLOY TILES ON C.D.A. STAND

THE attractive colour finishes obtainable with copper and its alloys are used to good effect on the B.I.F. stand of the Copper Development Association, D.232. The entire surface of the main stand structure is covered with 7-in. square tiles of copper, brass, nickel silver and gilding metal. The effect is not only highly decorative but is a useful reminder that copper and copper alloys are fully available for unrestricted use. The design of the stand is by the Association's Architectural Consultant, Mr. A. L. McMullen, M.A., F.R.I.B.A., and includes on the left a small projecting screen, also faced with metal tiles. On the outer face of the screen is an attractive sculptured display by Mr. A. W. Farmer in copper sheet in contrasting tones. Five display recesses, two in the side screen and three at the front, contain photographs of applications of copper and copper alloys, and advice to users that "To Make the Most of Copper" they should "First Ask the C.D.A." Also on the stand are some striking examples of uses of copper and copper alloys, and the full range of the Association's free publications.

NEW B.S. FOR DUST MASKS

THIS British Standard, B.S. 2091, 1954, applies to canister respirators and dust respirators which give protection against only a limited range of hazards. It is intended that this standard shall be amplified from time to time as further knowledge becomes available.

In its present form it covers hazards, encountered principally in the petroleum industry, but many of the hazards listed are encountered in other industries.

The standard specifies construction, marking and test requirements for canister respirators ("Gas masks") affording protection against the limited concentration of the gases listed, against each of which is listed the respirator canister which will give protection or, alternatively, the recommendation to use breathing apparatus; it also specifies requirements for respirators ("Dust masks") giving protection against dusts. It embodies recommendations in an appendix for dealing with other hazards beyond the scope of canister and dust respirators and describes suitable equipment.

Copies of this Standard may be obtained from the British Standards Institution, 2 Park Street, London, W.1. Price 4s.

THE CHEMICAL INDUSTRY

THE Association of British Chemical Manufacturers have found that, of recent years, there has been a decline in interest in the Chemical Section of the B.I.F. at Olympia. Thinking there may be a closer affinity between the Chemical Industry and those industries which habitually exhibit at Birmingham than there is between the Chemical Industry and those which exhibit at Olympia, the Association has decided to have a stand this year, at Castle Bromwich, on which twenty leading chemical companies will have separate display units. Meanwhile a committee is examining the feasibility of promoting separate specialised exhibitions for the industry.

ULTRA-VIOLET RAYS IN INDUSTRY AND COMMERCE

HANOVIA LTD., of Slough, leading manufacturers of ultra-violet equipment for medical, scientific and industrial purposes, held an Exhibition in conjunction with the Midlands Electricity Board during February.

The Exhibition showed the application of ultra-violet rays to industry and scientific research. Among the exhibits are an ultra-violet Water Steriliser capable of handling up to 2,000 gal. of water per hour, equipment for air sanitation for use in pharmaceutical and food factories, fluorescence lamps of various types for a variety of purposes, ranging from the detection of cracks and flaws in metal castings to the quick differentiation between fresh and preserved eggs. Lamps for the "cold welding" of perspex and the commercial production of vitamin D were also on show.

There are few branches of industry which cannot be served in some way or another by ultra-violet rays, and the Exhibition gave a very good idea of the versatility of this useful industrial and scientific tool.

Zinc Sulphide Pigments

Their Role in the Development of Water Paints and Value in Modern Emulsion Paints

WHILE the earliest records of civilisation contain many undoubted references to zinc oxide and its use as a medicine and pigment, the zinc sulphide pigments seem to have remained unknown until early in the nineteenth century. Their history has been very short, which makes it all the more surprising that no one seems to know for certain who first made them. Possibly, at some time during the early part of the nineteenth century, it was noticed that zinc oxide paints gained in opacity when exposed to industrial fumes and that a new pigment, zinc sulphide, was responsible. Certainly by the middle of the nineteenth century zinc sulphide was known to be a stronger pigment than zinc oxide, and among early workers with this new pigment the Belgian, de Douhet, deserves mention since he filed a British Patent in 1850 which describes its production.

Little practical use appears to have been made of his work until about 1867, when John Bryson Orr developed zinc sulphide pigment manufacture on a commercial footing as a result of experiments carried out in Glasgow. His British Patent in 1874 (No. 517) described the preparation of zinc sulphide and a range of co-precipitated zinc sulphide and barium sulphate pigments, in which the pigmentary properties were developed by calcination. In 1881 he followed this with another patent describing a comparable range of calcined zinc sulphide/strontium sulphate pigments. J. B. Orr is usually accredited with the discovery of this important calcination stage, since there is no evidence to support the view that de Douhet actually calcined his product. A copy of abridged patents, dated 1870, found among papers belonging to J. B. Orr, includes the patent of de Douhet in which no mention is made of calcination.

The industrial development of the zinc sulphide pigments is based largely on the barium sulphate type, and notably on the approximately equimolecular product, containing 28-30 per cent. zinc sulphide, which later became known as "lithopone". About 1880 Orr transferred manufacture to the Charlton works of the Silicate Paint Company and in 1898 to Widnes, where manufacture has continued ever since.

Independent manufacture took place in Belgium, based on a patent by V. Leger (1871) which is interesting since it contains the earliest known reference to the word "lithopone". In the 1880's the industry became established in both Germany and the U.S.A. None of these concerns can, however, claim the long unbroken run of production associated with J. B. Orr, who, quite rightly, has become known as the pioneer of the lithopone industry.

Manufacture

Zinc sulphide pigments are still manufactured by the method described in the original Orr Patent of 1874. The zinc sulphide is first precipitated by the interaction of a solution of a soluble zinc salt with one of barium sulphide. Solutions of zinc sulphate, zinc chloride, or mixtures of the two are used for this purpose, and are prepared by dissolving a suitable raw material containing zinc in the appropriate acids. Metals such as lead, copper, iron, cadmium and nickel, whose coloured sulphides would spoil the whiteness of the product, are then removed by rigorous chemical purification. Barium sulphide solution is prepared by reducing mineral barytes with coal or coke at around 1100°C., and barium sulphide extracted by allowing the hot product

to fall into water. The solution is allowed to settle and then filtered to remove unreacted carbon and impurities.

For lithopone, pure zinc sulphate and pure barium sulphide solutions are allowed to precipitate, while for zinc sulphide pure zinc chloride is used. Pigments of intermediate zinc sulphide content are made by combining the two processes. The precipitates are filtered, dried and calcined. During calcination a considerable growth in particle size takes place and pigmentary strength develops. The pigments are then ground to remove coarse aggregates, elimination of the latter being effected by separation in a current of water. The final stages are drying, disintegration and packing.

Traces of zinc oxide produced during drying or calcination are removed by extraction with dilute acid prior to the final drying stage. Cobalt is added as a cobalt salt before calcination to give complete lightfastness.

Water Paints

Since water is both cheap and plentiful, it is not surprising that paints containing a major proportion of water have been used from the earliest times. Solvents and vehicles were only needed with the comparatively recent introduction of the oil and resin media designed to provide a more durable paint film. The earliest paints were, in all probability, water paints either without a binder or held together with a protein such as egg albumen (the "tempera" of the early artist), or later by means of soluble silicates. Examples of all these finishes have survived to the present day, although glue, gums or casein have largely replaced egg albumen. A lime wash is a common example of an unbound water paint still used, while silicate paints have also survived in various modified forms.

Before lithopone arrived on the market, the quest for better adhesion and durability had resulted in the development of water paints based on drying oil/glue emulsions. Their use was, however restricted considerably since white lead—the white pigment in common use—was far from suitable for admixture. With the arrival of lithopone these coatings grew rapidly in popularity because of their easy application, and good single-coat opacity. They were relatively cheap, and possessed a satisfactory degree of adhesion and washability.

The lithopone and water paint industries may indeed be said to have grown up together, to a large extent dependent on each other. Lithopone has, in fact, proved the ideal pigment for these coatings and for the more washable oleoresinous emulsion finishes which later developed from them. This is not surprising since lithopone has just the right degree of pigmentary strength to give adequate single coat hiding, and to produce clean pastel-shade tints in conjunction with coloured pigments. The adequate pigmentary strength of lithopone, does not, however, mean that excessive adulteration with cheap extenders can be tolerated to a degree where opacity is lost, a fault common to many cheap finishes. In exceptional cases where still greater hiding power is needed, a high strength lithopone containing 60 per cent. zinc sulphide is available.

A further reason why lithopone has proved the ideal pigment for these coatings lies in its remarkably good facility for easy wetting and dispersion on milling. Lithopone is a versatile pigment, and can readily be produced with a range of surface activities giving just the right degree of surface activity to balance good brushability with excellent stability on storage. It is generally accepted by water paint manufacturers that a fairly high degree of surface activity is necessary, provided that it is not developed to an extent which restricts the ease of brushing, due to excessive consistency build up or thixotropy. This activity shows a tendency to stiffen during the early stages by milling so that further binder can readily be accepted, giving a resultant paste smooth in texture and having high stability on storage. The hiding capacity is then considerably in excess of that which would be obtained with a lithopone of lower surface activity. The smooth appearance of oleoresinous water pastes, the form in which these paints are normally sold, and the ease with which they can be thinned with water have long been considered

virtues only obtainable through the use of lithopone as a major pigment.

Emulsion Paints

Paints based on aqueous dispersions of synthetic polymers of high molecular weight have become very popular during the last few years. While they are to some extent replacing oleoresinous water paints, it would appear that they are probably making bigger inroads into the field of flat oil finishes. In the U.S.A. and elsewhere interest is concentrated on the styrene-butadiene emulsions whereas U.K. manufacturers have favoured instead emulsions made from polyvinyl acetate (P.V.A.), and to a lesser extent polystyrene emulsions. Emulsion water paints are supplied in a more fluid form than the pastes of the older oleoresinous finishes, and are supplied either partially thinned or ready for application.

These newer finishes have several advantages over conventional water paints. They are easier to apply, develop better washability more quickly after application, and adhere better, especially over fresh plaster, since the resins are more resistant to hydrolysis. The paints possess a considerable measure of outdoor durability; and can be formulated in finishes ranging from matt to a high sheen.

There are several drawbacks, notably the high cost of emulsion binders and their low tolerance towards high pigmentation. Other possible troubles include the difficulty of stripping the films for repainting, the attack on metallic containers during storage, and the instability of the emulsions especially in the presence of certain basic pigments and water-soluble salts. There is a considerable difference between the amount of pigment which the plastic emulsion and oleoresinous water paints can take up. A comparison can only be made on the basis of the content of non-volatile binder which remains in the paint film when it is dry, and such a comparison shows that the newer emulsion paints have a low tolerance to high pigmentation. Pigment/binder ratios of 10-1 are normally obtained with oleoresinous paints, giving a good single-coat hiding with lithopone. The newer emulsion paints demand much lower pigment/binder ratios if over-pigmentation is to be avoided. With titanium pigments for example, it is difficult to exceed pigment/binder ratios of 2-1 without developing cracking or chalking on drying. The need for high strength pigments is therefore apparent.

At the time when these newer finishes had reached the development stage in this country, the manufacture of high strength zinc sulphide pigments, suspended during the war years, had not been resumed. Manufacturers therefore naturally turned to titanium pigments and of the two forms, the rutile titanium dioxide has become more favoured. If the anatase form is used, the high surface activity of the pigment introduces difficulties in formulation, considerable thinning is necessary to give adequate brushing consistency, and the paint suffers loss of hiding power in consequence.

Hiding Power Tests

Some interesting results have been obtained from tests on the hiding power of emulsion paints pigmented in different ways. For each test, a black and white surface having a contrast ratio white/black of 80-1 was covered with a single coat of the paint with a wet film thickness of ·0025 in., and the contrast hiding ratio determined. This is defined as the ratio of the reflectivity of the paint over the black background divided by the reflectivity over the white background and multiplied by 100. With rutile titanium oxide as the sole pigment, it was found that the dry emulsion film had a contrast hiding ratio of 96 per cent. at the maximum pigment/binder ratio of 2-1.

Lithopone Brings Economy

Admixture of titanium oxide with lithopone has always been advised in the U.S.A. for improving the brushing characteristics of styrene-butadiene emulsion paints. U.K. manufacturers have found similar benefits with P.V.A. emulsion paints. Lithopone has the considerable advantage of lower water and binder absorptions compared with titanium pigments and can be supplied with very low thixo-

tropic tendencies. As a result the pigment/binder ratio with lithopone alone can be raised to 4-1 and much less water is required for thinning than with titanium pigments. Contrast hiding ratios of just under 90 per cent. can be reached with lithopone as the sole pigment—a better figure than might at first sight be expected. By mixing lithopone with rutile titanium oxide, higher degrees of hiding can be obtained, and a 50/50 mixture gives the same contrast hiding ratio of 96 per cent. found with rutile titanium oxide under the test conditions described above. This mixture represents an optimum as far as hiding is concerned and gives a durable paint with a pigment/binder ratio of 3-1. Such paints show appreciable economy in price per gallon compared with similar paints formulated on pure rutile titanium oxide. Further reductions in cost per gallon can be obtained by increasing the proportion of lithopone above 50 per cent., but a fall in opacity results.

It is obvious from these examples that the type of pigment required for maximum opacity, coupled with economy, in P.V.A. emulsions is one of low surface activity. This is the opposite of the requirements for oleoresinous water paints.

One rather surprising fact has been discovered as a result of exposure trials. Although lithopone and zinc sulphide pigments are prone to chalking in many exterior finishes, this tendency is not observed in P.V.A. emulsions. Thus both pure lithopone and lithopone/rutile pigmented emulsion paints show equally good durability. Admixture with lithopone also tends to reduce the chalking shown by anatase titanium oxide in pigmented films. It is interesting to note that lithopone-pigmented films are free from yellowing at elevated temperature (approximately 40°C.) under humid conditions and that addition of lithopone tends to reduce this failure with titanium oxide-pigmented paints.

Use of High Strength Lithopone

Although there is much to be said in favour of using mixed lithopone/rutile titanium oxide emulsion paints, the simplest method of formulation using zinc sulphide pigments is to incorporate the high strength pigment —60 per cent. lithopone. This pigment is now freely available and combines all the good properties of 28/30 lithopone with greatly increased hiding and reducing powers. At a pigment/binder ratio of 4-1, a contrast hiding ratio of 96 per cent. is obtained, matching that of films pigmented with rutile titanium oxide alone. The cost per gallon compares favourably even with the 50/50 lithopone/rutile paint previously mentioned. 60 per cent. lithopone is indeed the ideal pigment for P.V.A. emulsion paints, playing a similar role to that of 28/30 lithopone in the oleoresinous water paints. 60 per cent. lithopone is recommended for paints requiring a higher degree of sheen, and by its use delicate pastel shades are readily produced in conjunction with coloured pigments.

Stability of P.V.A. Emulsions

Much has been written about the doubtful stability of P.V.A. emulsions and the need for inert pigments free from soluble salts which may break the emulsions. Lithopone and zinc sulphide pigments meet these requirements and indeed appear to show greater compatibility with P.V.A. emulsions than titanium pigments. Their marked wetting and dispersing tendencies are such that the use of surface active agents for pre-wetting to form pigment/water pastes it not always necessary, as with titanium pigments. Many paints have been made directly by stirring zinc sulphide pigments into thinned P.V.A. binder followed by grinding through single or twin-roller mills, without any signs of even partial breakdown of the emulsion, and excellent stability on storage has resulted.

There is no doubt, however, that P.V.A. emulsions will not stand prolonged shearing such as occurs during edge-running or ball-milling. Here pre-grinding with water, or water to which some of the emulsion has been added, is essential, followed by addition of the bulk of the emulsion by high speed agitation. The usual types of wetting agents facilitate the grinding operation.

There is a tendency for P.V.A. emulsions to become acid on storage due to partial hydrolysis. This may

lead to attack on the containers. It is interesting to note that addition of lithopone and zinc sulphide pigments tends to inhibit this acid formation—more so than with the addition of titanium pigments. The hydrolysis may be considerably reduced by adjustment of the *p*H of the emulsions to a very slight alkalinity. This lessens the risk of container corrosion and also gives improvement in the light resistance of the pigmented films on exposure.

Plasticised Polystyrene Emulsions

This article would not be complete without some mention of the polystyrene emulsions containing large proportions of plasticiser, such as dibutyl phthalate. These appear to possess certain advantages over the P.V.A. emulsions which are now so popular in this country, and improved adhesion, washability and durability have been claimed. Unfortunately, these emulsions possess an even lower pigment tolerance than P.V.A. emulsions, and in consequence it is even more important that the pigment should have a high strength combined with low water and binder absorption properties. 60 per cent. lithopone and pure zinc sulphide are the two pigments most nearly meeting these requirements.

Conclusion

Enough has been said to show the remarkable parallel between the development of zinc sulphide pigments and the water paint industry during the last fifty years. Both industries have been largely dependent on each other for the materials required for their trade expansion. The excellent compatibility of zinc sulphide pigments is so obvious to water paint manufacturers that these pigments are certain to give continued service in the water paint industry, no matter what new developments the future may hold.

Reproduced, with acknowledgements, from the Zinc Bulletin published by the Zinc Development Association.

Change of Address.—Mono Pumps Ltd., have announced that their address is now: Mono House, 1 Sekforde Street, London, E.C.1.

LONGER LIFE FOR THE TURBINATOR

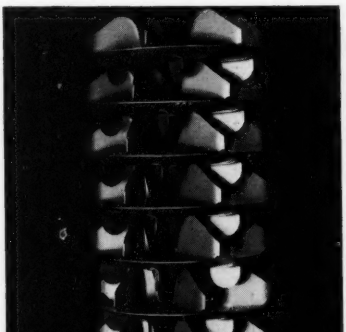
RUST and corrosion attack every kind of metalwork, including hair-drying machines—as was the discovery some time ago of W. L. Martin Electric Ltd., Birmingham. This firm are pioneers in the development of the "re-circulation" method of drying, and their famous Turbinator hair-dryer, incorporating this method, is a familiar feature of many hairdressing salons throughout the country.

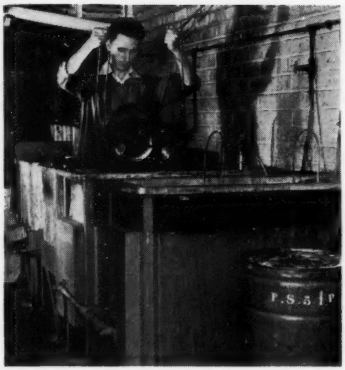
Aluminium alloy is used for all die-cast parts in the Turbinator, while the inner shell and the outer case are of heavy-gauge sheet steel. The finishing enamel, which is stove dried, is available in a variety of colour combinations.

Corrosion, which led twelve months ago to the installation of a jenolising tank, arose from what appeared to be chemical change on the steel parts, caused by the nature of the chemicals in current use in salons.

In addition, the trouble seemed to be aggravated by the presence of unventilated gas fires, since this appeared to give rise to a snuff-coloured formation on the enamel surfaces. The firm experimented with a number of processes, including the application of zinc chromate inks, in an attempt to stop the trouble; and an interesting series of tests was conducted over a gas glow which helped to reproduce the actual corrosive conditions.

A stack of Rotor assemblies after pretreatment and awaiting painting





Above: Part of the dipping and pre-treatment plant. Below: Completed Turbinators in the stores

Of these processes, jenolising was found to be the one most suited to the requirements of this firm, and a complete plant was installed. Owing to the types of metal involved, two distinct paint stripping chemicals must be used: Jenolite PS 5, which is for iron or steel components; and PS 7, which is more suitable for non-ferrous items such as the aluminium alloy parts mentioned above. These chemical solutions are placed in tanks, into which the components are dipped for a few minutes, during which time all paint is removed.

After stripping, both types of metal parts are dipped into the rust remover and neutraliser tank, where all rust is removed, and the surface of the metal is rust-proofed and "keyed" for good paint adhesion.

This protective scheme, which is followed by normal applications of the finishing enamels, has been found entirely satisfactory. No further trouble has been experienced on components even though the ammonium sulphate, much used by hairdressers as a neutralising agent, is extremely hostile to lead-based enamel.

These measures have also found much success in renovation work. The value of this side of the work is emphasised by Mr. E. A. Patterson, managing director of the firm, who says: "Our Service Department is often called upon to renovate machines twenty years old or more. We have found that the process turns them out so like new that, from appearance alone, it would be quite impossible to distinguish them from Turbinators in current production."

D.S.I.R. ANNUAL REPORT

A MORE cheerful note than has been apparent for some years is struck by the Advisory Council in the report for the year 1952-53 of the Department of Scientific and Industrial Research, published as Comd. No. 9083. The Council record their satisfaction that a plan has been agreed for substantial growth of the D.S.I.R. over the next five years. The plan, say the Council, "affords us firm ground on which to advise how best to allocate the resources we may expect to be made available and on which to base forward policy." Nevertheless, the Council's report quotes some examples of the difficulties owing to lack of resources in the past. "It is most regrettable that, in the circumstances, some inquirers should have to get their investigations carried out abroad and we look forward confidently to the Station's contribution increasing in scope and importance in a way which will fully justify the decision to create it."

In a note on the future, at the end of their report, the Council say that a specially welcome feature of the proposals for the next five years is the provision that a shortfall of expenditure in any year may, subject, of course, to the necessary funds being voted by Parliament, be made good in subsequent years. "This," say the Council, "will give the flexibility on which we have laid so much stress. . . . The broad effect of the arrangements will be to bring the D.S.I.R.'s post-war plans nearly to completion by 1959. We are greatly relieved to see this clear road before us."

American Finishing Developments

A DIGEST OF THE ARTICLES DEALING WITH FINISHING PROCESSES, WHICH HAVE BEEN PUBLISHED IN U.S.A. TECHNICAL JOURNALS.

A Good Simulation of Toasted Mahogany Finish can be obtained on low-priced ordinary veneer by wash-coating with a watery-thin white lacquer enamel without preliminary bleaching. This method is much easier and quicker than the usual method, which requires the use of bleached wood, or a very light veneer washcoated with either a clear water-white lacquer, or lacquer coloured slightly with a light brown stain.—*Furniture Manufacturer,* August 1953.

Improved Chemical Chromating Process Cleans Aluminium Airframe Parts Economically and Efficiently. An improved economical and highly efficient method of preparing and cleaning aluminium airframe parts for painting used at Lockheed Aircraft Corporation, Burbank, California, is the chromodise-iridite process, which deposits an iridescent film on the part by simple immersion in chemicals. Replacing the chromodise-anodise system formerly used, which oxidised the aluminium surface through electrolysis, the new method is said to be more efficient, rapid and economical.

Centrally located in a special metal processing department, nine 52-ft. long metal processing tanks 12 ft. deep and 4 ft. wide are used for the new processing method. The cleaning sequence is as follows: (1) Hot soap cleansing tank; (2) acid etch tank to prepare parts for iridite; (3) an iridite tank; (4) one chromic acid tank for treating alclad aluminium parts to be painted; (5) two spray rinse tanks; (6) two dunk rinse tanks; and (7) one drying tank.

Each tank has an 18,000-gal. capacity. Special demineralisation apparatus is installed which can demineralise 15,000 gal. of water per day. The demineralisation process removes chemicals and minerals from the water so that it becomes the equivalent of pure rain water. This improves the rinsing qualities.

Specific advantages of the chemical chromating process include: (1) It provides a better base for paint adhesion, since coating is tough and pliable, whereas anodised surfaces are hard and brittle. (2) It can be applied on parts having dissimilar metals, whereas anodising requires that no metal other than aluminium be placed in the tank solution. (3) The system does not require special racks and racking procedures which were used to provide positive electrical contact for each individual part in the anodising method. Very little, if any, maintenance cost will be required for servicing baskets used in the process, and work will flow more rapidly and efficiently to and from other departments of the plant through utilisation of the centrally located iridite system.

Use of the new system has considerably reduced metal processing time. Formerly a 1½-hour operation, the entire job can now be done in 47 min. Metal parts that required up to 45 min. for chemical treatment alone, under the anodise system, now can be processed in less than 5 min., it is reported. (*Steel,* 3rd August, 1953.)

An Inexpensive Spray Gun Cleaner where lacquer is used is a mixture of about 15 per cent. denatured alcohol, 35 per cent. ethyl acetate, and 50 per cent. toluol. Spray this solution through the gun until the spray is clear. Do not soak the gun in this or any other cleaning solvent as it will destroy all lubrication and make it necessary to take the gun apart for proper drying of parts and greasing.—*Furniture Manufacturer,* August 1953.

Hand-rubbed Shellac Finish for reproductions of mahogany or walnut furniture simulates the tone and colour of the original pieces. On mahogany pieces, apply a chrome stain first, then use an oil filler with a 2-lb. cut shellac for a sealer coating. After high-lighting with a shading gun, spray three coats of 4-lb. cut orange shellac to form the top coat. After the finished surface has dried thoroughly, hand-rub the furniture piece with fine pumice and a lubricant mixture of linseed oil and turpentine.—*Furniture Manufacturer,* August 1953.

An Inexpensive Blonde Oak Finish. First, use a white silex filler. Next, spray an overcoating, made by mixing a small amount of colour in oil with flat white paint, over the filler and allow it to dry for about 15 min. All free material should be wiped off and the sprayed sur-

face allowed to dry overnight. Then, rub down all surfaces with 3/0 steel wool and apply two coats of clear lacquer (water-white lacquer), rubbing with 3/0 steel wool between coats. When the lacquer top coat is thoroughly dry, apply paste wax and again rub with 3/0 steel wool. The number of wax coats used depends upon the gloss required.—*Furniture Manufacturer,* August 1953.

Co-ordinated Pre-finishing Handling Operations Permit Economical Mass Production of Television Cabinets. Close co-ordination of pre-finishing operations and improved handling methods in preparing wooden radio and television cabinets for the finishing room eliminate lost motion, wasted man hours, and make mass-production finishing of superior quality cabinets possible for the Smith Cabinet Manufacturing Co., Salem, Indiana.

Sanding and Sizing. Before assembly, all exposed plywood parts are belt-sanded with No. 3/0 sandpaper; panels are spry-coated with glue size and run through a conveyorised dryer for 9 min. at 130° F. Wet glue size not only raises short surface fibres of the wood but also hardens them. Therefore, when the panels are belt-sanded with No. 4/0 sandpaper, the raised fibres are cut off clean instead of being pressed down flat again. The glue size gives the entire wooden surface a uniform finish, and when assembled has a smooth, clear, and clean appearance.

The glue size is made up of eight parts of water to one part of animal glue jelly. The water contains an alkali solution of 6 oz. of baking soda to 5 gal. of water. This solution neutralises any fatty acids in the glue, which might damage the final finish of the cabinet.

After these pre-finishing operations are completed, the cabinets are delivered by conveyors to the finishing room, carefully inspected, and the inside surfaces spray-coated with a non-grain raising stain.

Staining, Filling and Sealing. Six spray booths, located just inside the finishing room, provide flexibility for handling several different kinds of finishes: mahogany, walnut, oak, and maple. Mahogany and walnut console cabinets are placed on one of four filler conveyor lines. The conveyors are of the cross-slat type, 18 in. above floor level, and driven through a variable speed drive with speeds of up to 5 ft. per min.

These cabinets are sprayed with a combination stain and filler at an atomising pressure of 15 lb. per sq. in. After air drying for 5 min. the filler is padded in with a portable air-driven padding machine. Cabinet sides are hand-jadded and tops given a second hand-padding, followed by clean-up operations which remove the protective paper backing from the grain transfer stuck to cabinet doors. The filler coat is dried in a conveyorised oven for 96 min. at 140° F. and at a relative humidity of 7 per cent.

After the cabinets are removed from the filler oven, they are allowed to cool for 10 min. before sanding of all solid wood parts with No. 320 sandpaper and blowing with air guns. This is an off-conveyor operation and, together with the separate filler oven, gives flexibility to the finishing set up.

Cabinets proceed to a sealer conveyor line when they are sprayed with a 21 per cent. solids lacquer sealer at 55 lb. atomising pressure and 20 lb. fluid pressure. They are allowed to air dry for 7 min. before entering the sealer oven where they dry for 20 min. at 120° F. After sealer coat has cooled for 5 min. it is thoroughly sanded with No. 240 sandpaper. Portable electric sanders are used on tops, but cabinet sides are hand sanded and blown clean with air guns.

Final Finishing. The cabinets are inspected for colour and placed on one of the two top coat conveyor lines. A first coat of 24 per cent. solids clear lacquer is sprayed over the cabinets at 55 lb. atomising pressure and 20 lb. fluid pressure. This coating is allowed to air dry 10 min. before cabinets enter a drying oven for 30 min. at 125° F. and 20 per cent. relative humidity.

Upon leaving this oven, cabinets travel for 30 min. to cool, after which they are inspected for defects. Burn-in and colour patching operations are performed, and trade name decals applied. The second coat of clear lacquer is applied at pressures similar to the first coat and allowed to air dry for 14 min. before being dried in the oven for 1½ hours at 130° F. and 20 per cent. relative humidity.

Machine and hand-rubbing operations follow after the second lacquer coat has cooled for 2 hours. Portable air-driven rubbing machines are used on cabinet tops, using No. 360 wet or dry sandpaper. The lubricant consists of 5½ parts naphtha to 1 part of light rubbing oil. After machine rubbing, the tops are rubbed again by hand, as well as the fronts and sides, and the cabinets then cleaned with cheesecloth. Rubbed-through spots are patched, dried, and rubbed again.

After rubbing and patching operations have been completed, the cabinets are moved into the polishing room and a 3-M compound (similar to a very fine-grit Rottenstone or pumice finishing compound) applied, followed by a thorough cleaning with a water-soluble liquid polish. The inside as well as outside surfaces are well cleaned, small defects coloured-patched, and after inspection

the cabinets are moved to upfitters, where hardware is installed.

Table Model Cabinets Get Special Handling. The method of handling and finishing table model cabinets differs from that used for console cabinets, due to difference in weight and size. Three separate overhead monorail cable conveyors—one for filler, another for sealer, and one for top coat lacquer operations—are used to handle the smaller cabinets. The wood-finishing procedure is similar but, after staining and filler operations, the cabinets are hung on a conveyor, two to a rack, which carries them to ceiling height for a 4-hour drying period. After spraying the cabinets with a solids lacquer, the operator hangs them on the sealer conveyor to dry for 45 min. At the sealer booth, the conveyors are close enough together so that cabinets may be taken from one conveyor, sprayed, and hung on the other conveyor with ease.

These table cabinets, after being hand-sanded, blown clean, and colour-shaded, are placed on a short section of gravity roller leading to the next spray booth. Here, the cabinets are tack ragged and sprayed with a coat of hot lacquer. The lacquer is a 32·2 per cent. solids lacquer which passes through a circulating type paint heater. Temperature is set at 160° F., and after passing through a 6 ft. hose, the temperature remains about 154° F. at the gun. The hot lacquer is sprayed on the cabinets at 65 lb. atomising pressure and 20 lb. fluid pressure, after which they are hung on an 800-ft.-long finish conveyor to dry overnight. Hardware is then installed, inspected, and the cabinets packed.—*Industrial Finishing,* March 1953.

Removing Surplus Filler from Small Sharp Corners. When wiping up fillers from sharp corners, care must be taken not to let the wiping rag over-ride the corners. Regardless of the lightness of the wiping pressure, the surface is too small to resist even the slightest pressure. An uneven pressure on an edge where small sharp corners can only hold a small amount of filler will result in it wearing through the finish. It is best to use a bristle brush, with a light touch, when removing fillers from sharp corners, or to fold the wiping rag over a picking stick.—*Furniture Manufacturer,* August 1953.

Silk Screen Paint for Decorative Purposes. Silk screen paints or enamels should have flow enough to produce a sharp print line. Tests show that where no fine detail work is required, as on large printing areas, the best results are obtained when using from No. 6-10 screen with a 60-sec. flow gauge reading ranging from 23-25 units, a 30-sec. reading from 19-22 units, and a 10-sec. reading from 16-18 units at a temperature of about 77° F. Where fine details are required, best results are obtained with No. 12 screen or finer with a 60-sec. reading from 16-18 units, a 30-sec. reading from 15-17 units, and a 10-sec. reading from 12-15 units. These tests were made with a flow gauge and do not include any viscous drag evaluation. The viscous drag of good silk screen paint should always be at a minimum.—*Furniture Manufacturer,* August 1953.

W. EDWARDS & CO. (London) LTD.

W. EDWARDS AND CO. (LONDON) LTD., manufacturers of high vacuum equipment, officially opened new premises at Manor Royal, Crawley, Sussex, on 5th March, 1954, the ceremony being performed by Sir Ben Lockspeiser, secretary, Department of Scientific and Industrial Research.

The company have expanded over the past thirty-five years from a one-man business to the present-day 500 employee organisation, and to mark the opening of these new premises over 350 guests were invited to luncheon. Sir Ben Lockspeiser, proposing the toast of "The Company and High Vacuum," said that the company "is an excellent example of a specialist firm occupying a unique position and serving both industry in the newest technology and science in its most advanced technique, in discharge tubes of all kinds, in the electron microscope, in the separation of isotopes, in accelerators for nuclear particles and in various branches of metallurgical research."

Chemical Technology Chair at Edinburgh.—A Chair of Chemical Technology and a new degree of Bachelor of Technological Science (B.Sc. Technological) have been approved by the University Court of Edinburgh University. The decision has been taken in co-operation with the Heriot-Watt College, Edinburgh, where the Department of Chemical Technology will be housed. The new emphasis is in keeping with the assertion nationally and locally that a fuller flow of trained technologists is necessary. There are already facilities for civil, mechanical, electrical engineering training and addition of chemical industry status completes the four main branches of the industry.

LETTER TO THE EDITOR

SIR,—As one with twenty-eight years' experience in the packaging trade, it was interesting to read, on page 561 of the current issue, that an overseal of aluminium can prevent pilfering. Can you explain how such a capsule can stop anyone taking the contents either through the orifice or via a hole pierced in the wall?

Advertisements frequently state "Pilferproof" and/or "Tamperproof." I know what "waterproof" and "fireproof" mean, so that if the two former words are taken as meaning proof against tampering and pilfering, then the package must be constructed like a bank vault. If, on the other hand, the words "Tamperproof" and "Pilferproof" mean that one can detect such tampering and/or pilfering, then my suit can be said to be (a) waterproof after it has been saturated with rain; (b) fireproof after being burned with a cigarette end.

Surely, apart from a "Fort Knox" container, no seal, capsule, strapping, etc., can *stop* tampering or pilfering, and it does not need a special fitment to indicate that a container is empty.

Yours faithfully,
ANDREW A. SIM,
Managing Director.
R. R. Gray and Co. Ltd.,
Keg and Drum Manufacturers,
41 Stanhope Street, Liverpool 8.

ELEVENTH DESIGNERS' CONFERENCE

The British Colour Council's Interior Decoration and Design Division will hold their eleventh Designers Conference this year from 3rd May to the 7th May. The conference in London will open with an informal dinner at Martinez Spanish Restaurant on Monday, 3rd May.

On Tuesday the 4th May, the opening session will be "The Retailer as Co-Ordinator." Chairman: Mr. George Breeze—Director, Lewis's Ltd., Speakers: Mr. Hilary Blackmore—Managing Director, Liberty & Co. Ltd., Mr. Maurice Catesby, M.C.—Director and Carpet Buyer, Catesby's Ltd., Mr. P. Edwards—Furnishing Contracts Organiser, Druce & Co. Ltd., Mr. Barclay Jacobs—Merchandise Director, The Times Furnishing Co. Ltd., Mr. Norman M. Lane—Managing Director, E. T. Lane & Sons Ltd..

On Wednesday, 5th May, visits are being arranged in connection with the retail session. In the afternoon the session "Designers in Discussion" will be based on samples of current productions submitted from member firms. On the morning of 6th May, Mr. Martin Briggs, F.R.I.B.A. will give an illustrated talk on "Wren's Work in the City of London."

On the 7th May, an Open Forum will be held. In the afternoon, tickets will be available for any delegates wishing to visit the B.I.F.

Six thousand gallons of varnish, worth between £5,000 and £10,000 went up in flames at a fire at Allied Paints and Chemicals Ltd., Wharfdale Road, Tyseley, on Wednesday night (17th March). Firemen from five Birmingham stations fought for an hour, during which thousands of gallons of foam were used, before the fire was under control.

Mr. Brian Millward, one of the workers, saw flames breaking through the roof of a storehouse as he was leaving for home.

Workers, including the assistant works manager, Mr. Edward Minchin, grabbed hand extinguishers and fought the flames till firemen arrived.

The brigade sent fifteen appliances—including a foam tender, salvage tender, and mobile control unit. Mr. Minchin said later, "Production will have to be slowed for a while."

New Van Design Speeds Loading.—Quicker turn-round of this new type I.C.I. Paints Division delivery van is achieved through side and rear loading and unloading. When fork lift trucks are used, as in the picture, hand lifting is largely eliminated because all parts of the van interior are near to the fork. The vehicle is a 13½-ton capacity box van on a Foden eight-wheel chassis. The bodywork—to an I.C.I. specification to comply with the Petroleum Spirit (Conveyance) Regulations—is by Bowyer Bros. (Congleton) Ltd. and the paintwork was carried out by Collings and Stevenson (Contractors) Ltd., of Acton, W.3. The van is painted with "Dulux" Coach Finish.

Monsanto Chemicals Ltd., announces that it has recently completed construction of a tonnage-scale pilot plant from which a range of styrene-butadiene rubber-like resins will be available from July of this year. A sum in the region of £500,000 is also to be expended on a large-scale plant which will commence production in approximately two years, with a planned initial capacity of 4,000 tons per annum of these materials. This early expansion has been made possible by the company's strong existing position and manufacturing facilities in the styrene polymer field.

NEW DEVELOPMENTS AT THE B.I.F.

Two interesting new developments will be displayed by Alfred Bullows and Sons Ltd., on their indoor stand at the B.I.F. this year.

Bullows-Binks Spray Gun

The Bullows-Binks Model 19 spray gun is the first result of a manufacturing agreement between Bullows and the Binks Manufacturing Co., of Chicago, the largest manufacturers of spray painting equipment in America. The Model 19 is a high performance spray gun with continuous paint supply. It has regulators for air and paint supply and repackable glands on both air and paint valves. It can be fitted with the standard range of tips and caps.

Rotating Spindle Automatic Sprayer

The Bullows-Berridge rotating spindle automatic spray painting machine is the result of collaboration with Berridge Aircraft Ltd., of Nottingham. This machine is a simple but versatile one for high-speed automatic painting of articles of near circular section up to a maximum of 12 in. in dia., and it will be shown at work on textile bobbins, applying multi-colour identification bands and also with a patented flock spraying attachment for the application of cotton flock to textile bobbins.

Other Equipment

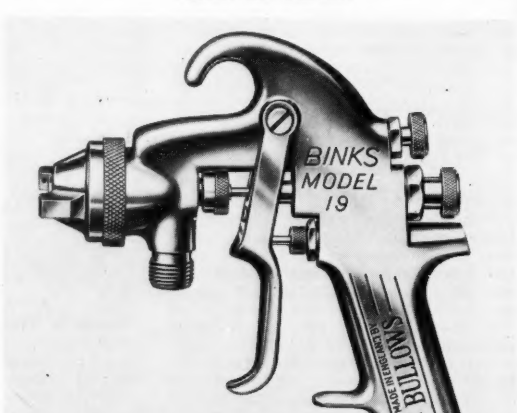
The standard range of Bullows spray painting equipment will also be shown. Both the indoor and outdoor stands provide an opportunity for the first composite exhibits of Hydrovane Compressors manufactured by the British Hydrovane licensees, Alfred Bullows and Sons Ltd., the Burtonwood Engineering Co. Ltd., and the Hymatic Engineering Co. Ltd.

Plastic Conduit and Fittings.—The General Electric Co. Ltd. has developed a conduit tube made in P.V.C. which can be used for electrical installations where severe corrosive conditions exist. It is resistant to the majority of acids, unaffected by moisture or damp, oil or grease, and may be buried in the ground, lime, mortar or cement. It is lighter than steel or aluminium, is non-inflammable, does not split or fracture, and remains rigid in temperatures up to 140° F.

The constituents of the tube are so balanced as to enable it to be manipulated and handled like steel conduit so that the wireman does not have to learn a new technique. So far as limits and size are concerned the tubing conforms to British Standard 31. The P.V.C. tube complies with I.E.E. wiring regulations Nos. 1301/5, 11th edition, for non-metallic conduit.

JOHN PRESTON GOLF TROPHY

The 1954 eighteen-hole bogey competition for the John Preston Golf Trophy is to be played in the afternoon on the 24th April at Ashford Manor Golf Club, Middlesex. Free transport will leave the Russel Hotel at 1 p.m. and return there by approximately 7.0 p.m. Afternoon tea will be provided and all visitors are welcome.



Binks Model 19 spray gun for operation from a paint line or pressure pot

A Problem and Its Solution

AN interesting story was told recently by Mr. J. Palmer, A.M.I.Mech.E., senior industrial engineer, North Western Gas Board, Liverpool Group, when he was addressing the Manchester District Junior Association of Gas Engineers. Mr. Palmer was describing the uses of gas on the Kirkby Training Estate, Liverpool, and was discussing the drying of paint by gas-fired stoving ovens. He said:

Recently we were asked to provide the burner equipment for a box oven that a small firm were making themselves. Normally we do not encourage firms to make their own equipment nor do we like to give them drawings for any type of equipment that is made by a reputable manufacturer. However, this oven was partly made when we were called in, being made in double-cased sections, with flue and air inlets to our suggestions. On completion, samples were sprayed and dried satisfactorily before production began.

After many months of satisfactory service we were again called in, as instead of obtaining a hard gloss finish on the parts sprayed, a matt finish predominated. The paint manufacturers had been called in and, of course, they said that their paint was all right and it was most probably the gas that was causing the trouble.

To check the oven for our own satisfaction and to prove our point, samples of the gases were taken from the oven and checked for CO and CO_2. CO was nil and CO_2 was slightly less than 1 per cent. The gas rate was checked and the oven temperature checked for evenness. Samples were placed under the microscope and it could be clearly seen that the paint had dried glossy but had an uneven surface. The refraction of light on the uneven surface gave a matt effect.

The paint manufacturers then supplied an anti-frost mixture (amyl-acetate or xylene) to be mixed with the paint before spraying. This helped considerably and the fact that grey was the least affected, then cream, then white, made the problem more difficult.

During this period it had been noticed that the weather had become more damp, and we attempted to create similar conditions to these in our laboratory with dishes of water and a small furnace but on each experiment a good finish was obtained.

Finally, it was decided to check the air line in the paint shop, where upon inspection it was found that condensation had been allowed to collect in the filter so that the compressed air picked up moisture in small particles and sprayed it with the paint.

Immediately this was placed in the oven, the moisture evaporated leaving an orange peel effect on the surface.

Mr. Palmer then gave the following report on the probable causes of defective finishes in high gloss stoving enamels in the hope that it would be of value to others who might be faced with similar problems in the future:

Gas-fired Stoving Ovens, Probable Causes of Defective Finishes on High Gloss Stoving Enamels.

The following data is provided to form some guidance in determining the probable causes of defective finishes that may arise when curing stove enamels in gas-fired hot air ovens.

In many instances when bad results occur, it is the paint manufacturer who is assumed to be at fault, but due consideration must be made of the following factors:

(a) The method of paint application, as specified by the paint manufacturer, must be strictly adhered to.
(b) Mixing of new stove enamels with "overs" should be avoided.
(c) Storage of the enamels should be in a cool, dry place.
(d) The spray booths should not be located in close proximity to the stoving oven, or where any noxious fumes may be drawn into the oven; noxious fumes may be classified as any volatile alkalide or acid vapour

—degreasing plant, soldering, etc.

(e) Weather conditions may have a detrimental effect, for due to the variation in the viscosity of the paint with temperature changes, there will be an ultimate variation in the thickness of the sprayed paint coating. Paint thickness should not exceed ·003 in.

(f) When the articles are first sprayed, they should not be allowed to stand for more than 1 hour, because the volatile solvents will "flash," producing skin hardening. To reduce this effect, thinners, or anti-frosting mixtures are used to maintain even drying through the thickness of the paint coating.

(g) If either primers or fillers are used for conditioning the material surfaces before enamelling, each coat applied must be stoved separately unless the manufacturer specifies the "wet on wet" technique.

The most common defects that may arise with stove enamelling are as follows:

(1) Gas checking.—The effect produced is the crystallisation of the plasticisers due to excessive concentrations of CO_2. The normal concentration of CO_2 in a hot-air oven does not exceed 5 per cent. and is usually of the order of 1 per cent.

(2) Rivelling.—This effect is produced by the uneven contraction of the "flashed" paint skin surface, and the fluid paint undercoat, an analogy of which may be akin to ice on water. The "matt" or "bloomed" finish produced by rivelling is due solely to the refraction of light on the uneven surface. Crackling and mottling are artificial rivelled effects, produced by excessive temperatures and varying degrees of ventilation within the oven.

(3) Unsatisfactory enamel finishes may be obtained by bad ventilation of the stoving oven where the volatile vapours from the solvents tend to retard the drying of the enamel, prolonging the stoving time, and in many instances producing uneven drying. The normal drying times will vary from 30-60 min. between temperature ranges of 250°-600° F., unless otherwise specified.

(4) Orange Peel Effect.—The term is used by the trade to describe a particular pitted finish obtained on the surface of the paint after stoving. This defect is the result of water vapour being present in the paint mixture prior to spraying. To minimise the likelihood of this defect occurring, it is considered essential to fit small "Cyclone" filters in all the compressed air lines to the spray booths; the regularity by which these filters should be drained is dependent upon prevailing weather conditions. A further safeguard is to drain the compressor tank before the commencement of spraying.

Note: White and cream enamels have been proved to be the most susceptible to defects (1) and (2): they may be observed to have taken place within the first 5-10 min. of stoving.

The present-day technique is such that emphasis is made on the use of synthetic stoving enamels which are polymerised plasticisers dissolved in any of the following solvents:

(a) Xylene and naphthalin compounds.
(b) Amyl and butyl acetates.
(c) Phenol-aldehydes.

Any of the above solvents may be adopted for use as thinners or anti-frost mixtures.

Later in the course of his talk Mr. Palmer described the operations of applying insulating varnishes to copper wire at another factory on the same estate.

Copper wire is insulated by giving it a protective coat of varnish, which when baked hard is pliable and homogeneous.

In 1946 Connolly's (Blackley) Ltd. bought a site at Kirkby with the view to opening up a factory for processing copper wire. They adapted an existing building and installed several machines for enamelling wire, whilst plans were being passed and licences obtained for the main factory.

Early in 1951 the new factory was commenced and several services were planned to supply gas at varying points over a wide area. In addition to the existing service and 1,200 H.C. meter, three other services were installed; a 4,500 cu. ft./hour for the canteen block, a 15,000 cu. ft./hour for the boiler house and a 20,000 cu. ft. for the enamelling shop.

The enamelling stoves fixed in 1946 were electrically heated, but they did not fully meet the requirements of the management as they were wasteful. This point will be noticed from the following description of subsequent machines.

A further development to this machine had electrical elements and gas burners. During the stoving of the enamel, inflammable fumes are given

off, these are mixed with air and burned. The electrical elements are used to balance the heat along the length of the heating chamber and to vary the temperature where necessary.

This machine has been improved still further; the fumes from the enamel are taken up to a solvent recovery plant, then passed down the outside of the flue for preheating before burning and passing to atmosphere.

The machines that Mr. Palmer described are all horizontal and have a heating chamber varying from approximately 4-6 ft. in length. To lengthen these machines would take up valuable floor space, so the latest machines being installed at the Kirkby factory are vertical and will have a heating chamber length up to 20 ft.

The Town's gas is controlled by a gas valve of the needle type, having a small by-pass rate. This control valve operates in conjunction with an adjustable thermostat, the controlling medium being compressed air at 6 lb. per sq. in. The gas rate per stove varies from a minimum of 5 cu. ft./hour to a maximum of 20 cu. ft./hour.

Besides being more economical to burn these fumes, it is much safer than passing an inflammable mixture through the trunking of an extraction system.

The enamel is heated to a predetermined temperature in the storage tanks before passing to the stove where the wire is dipped. It is necessary that this temperature be controlled accurately if the final enamelled wire is to pass the British Standard requirements. This control can be obtained by installing a gas-fired boiler and circulating hot water or steam through the storage tanks.

The accompanying table shows the B.S. requirements for two sizes of wire to be enamelled.

	Nominal	*Copper wire*		*Enamelled wire*	
No.	*size*	*min.*	*max.*	*min.*	*max.*
50	·0010	·00092	·000103	·001121	·0014
30	·0100	·0099	·0101	·0108	·0113

SHIPPING SLOW-DOWN AFFECTS SCOTTISH FINISHING SHOPS

ACCORDING to our Scottish correspondent, a serious position is developing in shipbuilding, which must inevitably affect all the finishing industries, since ship construction is ultimately merely an assembly project involving thousands of finished or semi-finished products. Last year, he points out, there were some twelve Clyde yards which did not book a single new order; new orders taken on the river as a whole merely covered the cancelled ships; in effect, therefore, the major Scottish area lost a year of work, and although fully booked for 1954 and into 1955, is so much the worse for the loss of that year's cut in orders.

Other shipbuilding rivers fared similarly. The over-all effect is a definite decline in volume of work over all the country and not only in the shipbuilding areas, since there are thousands of subcontractors feeding into the main port areas. For such firms the loss of a year's work is vital; for paint and allied product makers the position may be relieved to some extent by alternative work.

Housing is still booming and demand for specialised finishes of this type will take up some of the loss. But there are many firms whose basis is less widely spaced and who have concentrated on specialities. The decline of any one industry must inevitably affect these concerns particularly. It is obviously unwise to bemoan a dire fate before it matures, but the position is undoubtedly one which will demand continuous attention and which may well result in serious difficulties for specialised firms.

Policy which is obvious is that firms so placed will seek to expand their scope and so survive, but the difficulty of achieving this in an increasingly competitive sphere is already evident.

Ancient and Modern Wood Finishing*

by B. M. LETSKY, M.Sc., F.R.I.C.

Although primitive wood finishing dates back for thousands of years, it was not until the advent of French polish, in the early days of the eighteenth century, that modern wood finishing was really born. Finishing techniques in furniture factories changed little from our grandfathers' time until comparatively recently. The last decade or so, however, has seen the introduction of a number of advances. Some of these, together with a review of the past methods, are given in the following pages.

IN wood finishing the modern craftsman attempts in a day what time does in a century, i.e., mellows, beautifies and softens the tones and markings of figured hardwood. It is said that man cannot improve on nature. The scientist knows better, men (and women) improve on nature every day. Man can, does and will constantly improve both nature and himself. In fact nature, through the process of evolution improves herself also. It is in this peaceful harnessed ingenuity, the continual interaction between inner urge and outer circumstance, that the essential divinity of man lies.

Wood finishing has a really enthralling history, which space permits us to touch but lightly. Where the ingredients were conveniently provided by nature, high-class wood finishing, is almost lost in the mists of antiquity. In China and Japan, Urushi work, the Chinese Lacquer we know so well, dates back thousands of years to what, for England, would be primitive ages. The sap of the tree *Rhus Vernicifera* hardens when brushed out in a warm, moist atmosphere to a very durable, heat-resisting finish, insoluble in water and most solvents. Chinese Lacquer work is one of the oldest industrial arts of the world. The raw material used is the first latex to be used for protective and decorative purposes. This is an interesting fact when latex paints are today, very much to the fore.

In India the *Butea Frondosa*, or Palas tree, one of the host trees of the lac insect, was known in Sanskrit as "Lakshatarii" for some two thousand years. It was only in the sixteenth century however, that the West received official cognition of the ancient method of finishing both wood and metal with Sticklac. In the report of a Dutch member of a scientific expedition to India in this century is clearly described, the melting of solid Sticklac on rapidly turned wood and metal articles, and subsequent polishing with a drop of oil on rough muslin. As indicated, it is probable that this method of wood finishing is almost two thousand years old.

The advance civilisations of Egypt, Greece and Rome were comparatively backward as far as wood finishing was concerned. In Egypt the Acacia tree was the only gum-bearing tree which grows freely, and it is not surprising that Gum Arabic was used as a binding medium for many fine scrolls and paintings still extant, despite its solubility in water. Pliny and Vetruvius in the first century A.D. described the polishing of marble and wood with candles and rough linen cloths. A grand old monk of the eleventh century, Theophilus to wit, describes in

* *A lecture given to the Midland Paint Students' Association at the Birmingham College of Technology. Published by arrangement with the author.*

great length and detail in several volumes of his "Diversarum Artium Schedula" formulæ and manufacture of glue, tempara (white of egg) and oil mediums, for paint and protective coatings on a variety of surfaces. Ceninna Cenninni, of Rome, discourses at length on the protective value of drying oil coatings applied over the tempara paintings of the masters of the day, in the early fifteenth century. In the sixteenth century the Van Eycks firmly established the use of drying oil as the artist's medium for pigments. As far as wood finishing proper was concerned, East was East and West was West and the twain had not yet met.

Small amounts of *sandarac, gummastic, amber, dragons blood,* and possibly shellac solution in spirits of wine, were beginning to be used about this time. It was not, however, until the introduction of french polish, that skilled wood finishing on a large scale was really born in the West. In 1730 the brothers Martin of France, obtained a four-year monopoly of the use of "Vernis Martin" which was essentially a solution of shellac in spirits of wine, worked on the wood using Linseed Oil as a lubricant.

Early reference to this process is difficult to find in Great Britain. High praise for it appears in the *Mechanics Magazine* of 1823. It is really from this time that the development of wood finishing in Great Britain as a separate craft, actually begins. Rapid strides were soon made on the original process, to reduce the time of working, the rubber. Filler was introduced to stop up the grain and the pores of the wood, and thus save considerable time. Tricks of the trade were introduced. The craftsman learned to dilute his shellac solution in the final stages of rubbing and "spiriting off" the oil, followed as inevitable developments.

The beauty of the full piano finish was impossible without these tricks of the trade and even in these modern times the clarity of the full french polish cannot be equalled without using some of the old technique of french polish.

Modern so-called experts on wood finishing, are too apt to discount the intrinsic soundness of historically proved methods and become enthusiastic about any method of wood finishing provided only that they are new, in the same way as the old french polisher is sceptical of any wood finishing process, except the old ones.

Until recently the standard of technical articles in trade magazines on the subject of wood finishing was very poor either because the authors did not know or did not want to divulge, the so-called secrets of old and new wood finishing. In fact, there used to be a deplorable tendency to tell the reader nothing, in as many words as possible but, nevertheless, to interest him in some proprietary lacquer, stain or polish or process which he might buy on the strength of the negligible knowledge imparted.

In an article in an Australian magazine, whose author shall be nameless, we are given the following pearls of knowledge and wisdom after five

B. M. Letsky, M.Sc., F.R.I.C.

Educated at Rutherford College and Kings College, Newcastle-upon-Tyne, and was graduated in 1927 with honours. From 1927-1931 he was employed as Chief Chemist for Elders Walker and Co., paint and glass manufacturers. In 1931 he was awarded the Master of Science degree for his work on fats and the structure of shellac. Mr. Letsky became Chief Chemist and Plant Manager of Commercial Lead Ltd. and joined the A. Learner and Co. Ltd. (Ault Wiborg Group) two years later. At the present time he is managing director of this firm and during the last ten years he has specialised in the application of organic coatings in the finishing field plus carrying on publicity and administration duties. Mr. Letsky was awarded the F.R.I.C. degree in 1948 for his work on developing a new process for manufacturing white lead and for his research work on abietic acid. In addition to the above duties he is now Director of Industrial Finish Development, Paints Division, Ault and Wiborg Group.

closely printed pages.

1. Piano manufacturers are traditionally conservative.
2. Piano finishing depends on careful selection of materials and thorough workmanship.
3. A piano is water stained, papered, sealed by shellac, filled twice, four coats of lacquer applied, one coat per day, and then papered down anything from 48 hours to three months after lacquering.
4. Four-and-a-half gallons of lacquer are necessary for a standard grand piano.
5. Pianos are not ordinarily polished bright but given a close, satin or matt finish.

Most of the above information is incorrect. Moreover, no practical details of real interest to the skilled wood finisher are supplied. No indication of the average time to be spent on a set of piano parts by french polish or cellulose is given. Even the approximate nature of the stains, lacquers and finishing solutions are not indicated. Not a word is breathed about the process of "spiriting off" with french polish or cellulose, by which 90 per cent. of leading makes of piano in this country are finished. In actual fact, a grand piano took 80-90 hours of actual polishing time, with cellulose "spiriting off" 30 hours, with cellulose burnish 22 hours.

The modern wood finish technologist is no witch doctor with secret and miraculous charms as a panacea for wood finish complaints. Like the modern physician he gets best results from intelligent and understanding co-operation with his patient. Such results *cannot* be obtained by telling the patient nothing, or even worse, giving him spurious information, which apparently is the chief function of the type of article criticised.

The necessary prerequisites for high-class wood finishing are that the final result is first class and stays that way. If wood were metal this would be easy. Remember that one of the fundamentals of all sound wood finishing processes is to minimise sinkage into the grain as far as possible, within the limits of practical production. If time, temperature and weather resistance were unimportant, I would say unhesitatingly that traditional methods still stand up the best. Unfortunately, or perhaps fortunately for me, as I would be out of a job, this is a world in a hurry. Willy-nilly, we have to examine carefully the old and the new and find therefrom the best compromise to give a good result in a reasonable time.

In the past the furniture maker was, as a rule, an excellent cabinet craftsman with a rudimentary knowledge of polishing. Until recently he was not particularly interested in the anatomy of wood finish, except in so far as it enhanced appearance and increased sales. Due to the rapid growth of mass production which has brought furniture manufacture almost into the realm of engineering production, he (the furniture manufacturer) has been compelled to call upon the cabinet maker, the chemist, the engineer and the polishing foreman to co-operate in order to meet the stringent necessities of time and space. This is the essence of modern wood finishing.

Clear wood finishing is, in general a much more skilled operation than pigmented finishing on metal. More variables are involved and more initiative is called for in practice. Only broad outlines of finishing procedure can be suggested here to cover the field of wood finishing. No rigid procedure for individual manufacturers should be outlined until all practical considerations have been thoroughly investigated. These factors include space available, proposed output, standard of finish, capital expenditure and selling price of the finished commodity.

It is the rapid expansion of the furniture industry which has raised fresh wood finishing problems and exaggerated old ones. Wood today is the same as it was thousands of years ago. Superficially, therefore, it would appear that the problem of finishing wood with protective and decorative coatings should be similar then and new. This is not so. The same quantity/quality problem which applies to all branches of organic finishing on metal, applies much more acutely to wood. The essential high speed of modern finishing raises not only the quantity/time problem, but brings to light new properties and qualities in both the timber and finishing materials. These must be considered before satisfactory uniform

results can be achieved. In brief, the qualitative basis of wood finishing had to be fundamentally changed before mass production results could be achieved.

When the craftsman of India pressed his stick of shellac against his hand-carved wooden vase rotating on a primitive lathe, he achieved a finish which lasted hundreds of years. Quality and durability were unimpeachable. Time and cost were immaterial. Today the problem is to equal and surpass this quality of finish on articles varying in size from a tool handle to a dining table. Furthermore, we must satisfy the world demand from a twenty-fold greater population with a thousand-fold increased consumption. That is why, although we cannot, and do not, disparage the achievements of the past; the furniture industry of today must make full use of the latest materials and application methods produced by the chemist and the engineer.

The range of wood finishes today covers clear finishes on all types of furniture, including air drying, low-temperature stoving, forced drying and hot lacquer application. In addition there are pigmented finishes for nursery and kitchen furniture, sports goods finishes, brush and tool handle finishes, heat resisting finishes for tea trays and dining tables, piano finishes and radio cabinet finishes. The nature of wood itself, does not help the mass production problem. Wood, unlike metal, is not homogenous in structure. The long hollow cells parallel to the vertical axis of the tree, establish at the outset that wood is much more stable dimensionally along this axis than at right angles to it.

The greater strength and stability of the inner heartwood against the outer sapwood are also axioms of the furniture trade. The paramount importance of the moisture content of wood is so generally recognised, that fully half the large furniture manufacturers in this country have constructed their own drying kilns to control this variable. The continual physical changes which occur throughout the useful life of timber, pose what appears to be an insoluble problem. How can a stable finish be applied to an unstable foundation? Fortunately, the amount of physical change diminishes rapidly with the age of the wood. Time heals many things. Before the feverish and contradictory urge for more and better production from a given space, time was a partner, not a competitor. The old craftsman, who was frequently an artist in his own right, allowed Time to mature his products, *before* completion. Two to six months might elapse before the old french polisher would apply his finishing rubber. The excellence of the finish of many fine period pieces testify to the soundness of his procedure. Today, in marked contrast to this leisurely and friendly alliance, Time is our bitter enemy. We carve large chunks out of his frame and squeal when he takes revenge. Remember that a saving in the time factor of up to 400 per cent. has been achieved by the conversion from french polish to cellulose finishing. It is this phenomenal increase in speed, which is the prime factor in the sinkage problem which affects all types of wood finish.

Sinkage can be defined under four main headings.

1. That sinkage due to the intrinsic nature of wood itself, viz., loss of moisture, change of dimension and absorption into the grain, which distorts the protective film.
2. Defects in the wood filler which sometimes gives insufficient filling and at other times produces "puffing" followed by subsequent shrinkage into the grain.
3. Defects in the sealer coat due to substantial solvent penetration into the sealer coat by the finishing coats.
4. Defects in the finishing coat due to evaporation of solvent after the final finishing operation and also to low solids in the material used.

Theoretically it should be possible to accelerate the natural rate of sinkage so as to improve the stability of the finish *before it leaves the factory*. The provision of forced drying facilities at the filler, sealer and lacquer stages would be of great value. In this way most of the natural sinkage could be achieved before the furniture leaves the factory. Moreover, finishing defects such as white in the grain (the Americans call it greying of pores), printing, blushing,

orange peel, etc., could be largely eliminated.

The natural reaction of the furniture trade against the stoving of furniture has been partly overcome. It is widely appreciated now that by maintaining the relative humidity of heated air at 35-45 per cent., furniture can stand temperatures of up to 140-150° F. for one hour. The possibility opens the field to a wide variety of raw materials. Awkward and incompatible solvents can be eliminated between operations. Low temperature polymerisation becomes at once of interest.

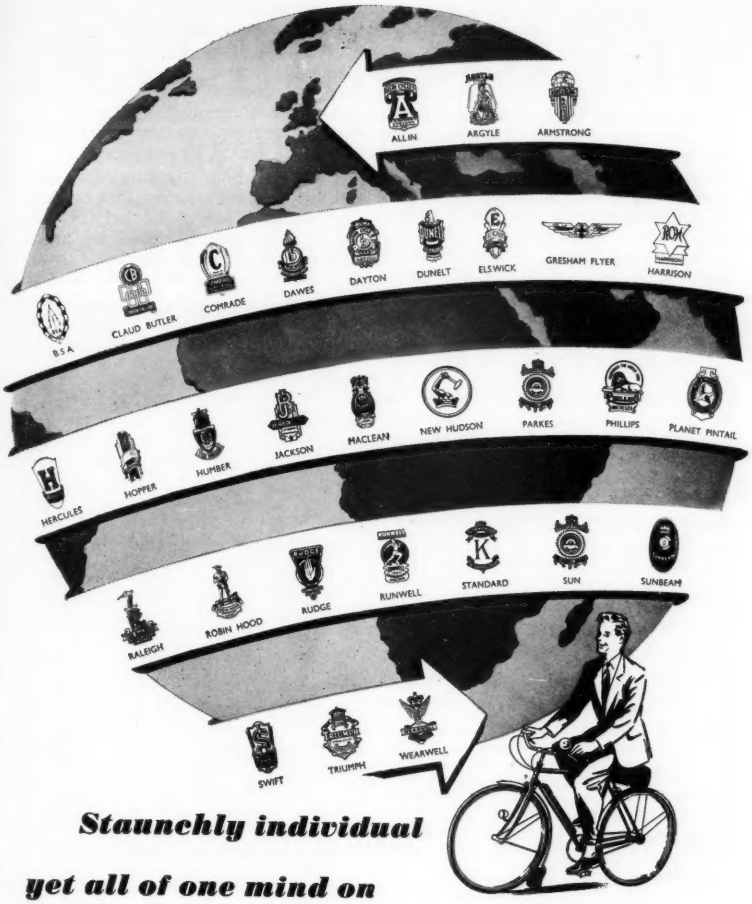
In order to give a general picture of the clear wood finishing process we will go briefly through the main operations and materials used in this country from white to finish, i.e., which are stain or stain fill, sealer, colour, lacquer, pullover and burnish.

The basis of good wood finishing must be established in the ground work. If the wood is not carefully sanded with fine paper as a finishing operation from the cabinet maker before finishing the fur of the timber and deep sanding marks will pick up stain and filler in a way that makes the final finish look uneven and muddy. At this stage bleaching of the veneer must be performed if required. For this purpose proprietary mixtures of hydrogen peroxide, hypochlorites, ammonium oxalate and oxalic acid are used, often in a first and second application, depending on the veneer. Sometimes, two or three applications of bleach may be necessary to achieve the desired effect. After bleaching, the work must stand overnight and then the raised grain must be papered down.

If bleaching is not required, the wood can be stained or stain filled. For natural coloured timbers a light stain or pigmented wash is applied direct to the wood by hand or spray gun and then sealed with shellac, nitro-cellulose or synthetic sealer, in a thin wash-coat. The filler can now be applied over the wash coat and in this way will not muddy the timber but will wipe off very cleanly leaving a clear figure. In the U.S.A. this method of staining, sealing and then filling, is known as the "glaze coat" method and like many things in the States which are standard and universal procedure here, it was covered by a variety of patents. In Great Britain the method has been used by all furniture manufacturers, for half a century, without any patent cover. Where the colour of the furniture is to be medium or dark, stain fillers which stain and fill in one operation are used. The filler, is usually applied by hand across the grain and wiped off cleanly with coarse sacking after about 10 min. Where there is a large output of furniture, the stain filler is sprayed through wide nozzled guns, from pressure pots which are mechanically stirred. Where the filler is applied by spray gun, at least four extra hands are needed to wipe off the filler and keep pace with the sprayer. If the design of the furniture includes mouldings, sharp pointed sticks should be used to remove excess filler from all corners. This gives a clean look to the finish and prevents "white in the grain" due to an excessive thickness of filler.

Where the grain of the veneer is shallow, as in birds-eye maple, birch, figured ash, sycamore, etc., filling, is unnecessary, and staining only may be used. Stains for wood, fall into four main classes. These are water stains, oil stains, spirit stains and permanent non-grain raising stains. The water stains comprise the traditional vandyke crystals, bi-chromate crystals, logwood chips, potassium permanganate, cochineal, etc. In addition, there comes a range of modern acid dyes which are soluble in water and also in carefully balanced mixtures of alcohol, carbitol, methyl cellosolve, toluol, or xylol.

These acid dyes are usually the sodium salts of organic acid dyes. They have a direct affinity for cellulose fibres, including, of course, wood. The oil soluble type, includes the water insoluble azo dyes, which colour the wood by absorption and deposition. These are not so fast to light. Spirit dyes are usually employed in spray shading stains and used to be, somewhat fugitive. Nowadays, however, Alcovar spirit soluble dyes are used and these show a marked improvement in this respect. Bitumens are still employed largely, in this country, for a wide range of oak, walnut and mahogany base stains. They are permanent and give excellent



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clarity. Moreover, they are soluble in a cheap range of solvents like white spirit, naphtha, toluol and xylol and are, therefore, very economical in use.

The question of wood filler or combined stain and filler, is still in a state of flux. The modern stain filler fills moderately well, dries rapidly, is easy to apply and remove, and gives a clear grain or figure. It is still by no means a perfect answer, to the filling problem. Usual formulations contain silica, china clay, barytes, burnt turkey umber, chalk, talc, slate powder, in mediums of oil varnish, linseed oil, gold size, white spirit, naphtha and xylol.

Insufficient organised and scientific attention as a rule has been given to the question of adhesion, "puffing in the grain," sinkage and compatibility with the final coats. The main criterions have always been ease of application, speed of drying and clarity of figure. The perfect filler would have the following properties:

1. Air dry in less than one hour.
2. Applicable by hand or gun, and easily wiped off.
3. Maximum clarity of figure.
4. No "puffing" or shrinkage in the grain under sealer or lacquer.
5. Good adhesion to the wood and to the subsequent coats of sealer or lacquer.
6. No raising of the grain.
7. Compatible with either sealer or lacquer.

There is no filler today, which meets all the above requirements. The best of them are working compromises. One of the severely limiting factors is, from the chemist's point of view the least important, and from the workman's point of view, the most important; if the filler will not wipe off easily 15 min. after application on a wardrobe or dining table, it is condemned out of hand, even although its other properties may be near perfection.

There are a number of mediums available today which could give many of the properties required for a first-class filler. Research on wood adhesives from 1940 onwards have indicated that in the main, they should polar in character to ensure maximum adhesion. These considerations obviously apply with equal force to wood filler. This factor is rarely considered when the filler is formulated. Spirit soluble phenolics, short oil alkyds, dispersion phenolics, shellac, catalysed ureas, are excellent for filling, adhesion, non-puffing and non-shrink properties. Unfortunately, their working properties make them difficult to use on large surfaces.

Use of high boiling alcohols, recently made available, like nonanol and decanol might be helpful, but then forced drying would be necessary to remove slow solvent. Further improvements may lie in the field of emulsion type fillers. It is possible also that mechanial methods of filler application and removal could alleviate this problem. Some attempt has been made with modifications of burnishing machines and sanding machines with partial success. It should be mentioned that puffing of the filler in the main, is caused by swelling of the oil or varnish medium by hydro-carbons in the subsequent coats.

When the filler is dry, which may take periods from one hour to twenty-four hours depending on the formulation, the sealer may be now applied. Shellac is still used by many manufacturers as a sealer. It is still superior to most air drying synthetic resins and standard cellulose sanding sealers, for solvent resistance and sealing properties generally. Its disadvantages are poor flow, thermoplasticity and the risk of adhesion and cracking difficulties if too thick a film is applied, under cellulose.

The standard nitro-cellulose sealer, is very convenient in use. It is hard dry in fifteen to thirty minutes, papers very easily to a satin-smooth finish and lends itself admirably to mass production technique. Until the last five years, the cellulose sealer has been low in solids and in resin and, in the main, gave a thin film which could be sanded smooth. Recently, however, the attempt has been made to incorporate more and more solids in the sealer in order to save time and finishing material costs. Synthetic resins like hard maleics and short oil alkyds have made this possible and there are a number of good quality high solid sealers based on cellulose combinations with this type of resin. This type of sealer flows well, hardens rapidly and gives

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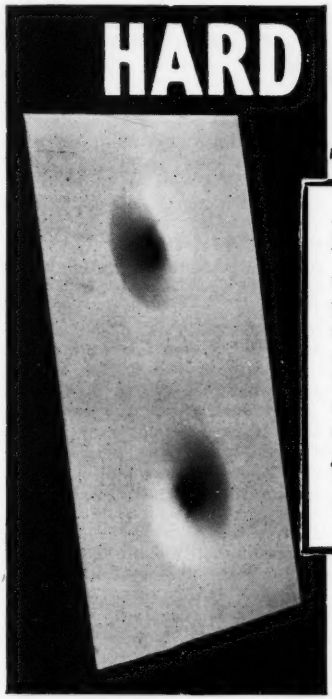

Untouched photograph

ERICHSEN PRESSURE TEST:
The steel plate illustrated is coated with Group 28 Stoving Finish. The plate was subjected to pressure from a steel ball on one side of the plate and a brass cup on the other. The depth of the depressions is $\frac{3}{8}$". *No film fracture whatever occurs—and yet it will withstand a scratch test in excess of 1,500 grammes.*
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great economy in the amount of finishing lacquer necessary to achieve a given result.

The necessity for rapid air drying severely limits the number of suitable resins which could be used in a high solid sealer. There has been increased interest therefore, in forced drying, and low temperature stoving for the furniture trade. One of the largest factories in the country has successfully used low temperature polymerisation of a catalysed urea-alkyd resin in bulk production for over four years.

The temperature used for the finishing coat is 140° F. for one hour. The sealing coat is a standard cellulose lacquer, forced dried at about 100° F. for fifteen to thirty minutes. The cellulose sealer, has a high resistance to the xylol butyl-alcohol combinations, used as solvents in the finishing synthetic resin coat. The air in the stoving chambers is humidified by steam injection up to 45 per cent. relative humidity. The finish has exceptional flow, toughness and heat resistance. It is superior in these respects to any cellulose finish. The capital expenditure however, is very large.

An alternative method to this, is to use a catalysed synthetic resin sealer or base coat for low temperature stoving; followed by standard cellulose finishes, with their gloss and flexibility in production. In addition to this there are a host of compromises using combinations of nitrocellulose, ethyl-cellulose and butyroacetates with the above resins. In this way, it is possible to get hard films in ten to fifteen minutes at temperatures as low as 120° F. Sufficient polymerisation is achieved to get good holding-out properties, but sufficient solvent sensitivity is retained to ensure good adhesion between the sealer and subsequent coats. This low temperature stoving is very convenient, because under such conditions even animal glue joints, are not attacked and humidification of the air is unnecessary. Considerable pilot scale and full production scale trials have been carried out successfully with electric infra-red heating, steam panel infra-red heating and standard convection hot air circulation methods. The number of factories with low temperature ovens operating successfully for forced drying filler, sealer and finishing coat has increased considerably during the last few years.

We have now applied our stain, stain filler and our base coat or sealer. The next operation is colouring, shading or matching. Due to the unequal absorption of stain by wood, it is necessary to level or match up the inequalities, using the appropriate colour, by either brush, pad or spray gun. Good colouring, is the hall mark of all high class wood finishing. Without skilled operation at this stage, the whole appearance of the finish can be ruined. This is not so much a material problem as a skilled application problem. Spray stains or solvent stains are solutions of fast dyes (sometimes with finely dispersed pigments) in the requisite solvents. The colour is bound by about 25 per cent. addition of cellulose lacquer, or in the case of spirit shading stains by shellac.

After the matching operation a thin coat of lacquer, usually called the "flash coat," is applied to bind the colour.

At this stage the finish should be flat and clean. The flatness is only maintained by the liberal use of hand or machine sanding at every stage, except on the matching colour. We are now ready for the finishing operation which can consume one, two or three coats of lacquer dependent on whether hot lacquer plant is used, or on the standard of finish required. Low solids lacquers are a thing of the past in this country. Competition between lacquer manufacturers is too keen and the mass production of furniture manufacturers on too high a level, to tolerate the low solids lacquer. Reputable firms supply cellulose lacquers ready for use at 30 per cent. to 40 per cent. solids content, whereas 15 per cent. to 25 per cent. solids, were frequent before the war.

The high solids lacquer has been made possible by the use of low viscosity nitro-cotton and the latest synthetic resins instead of ester gum. It is possible to formulate a cellulose lacquer with twice the resin content of pre-war lacquers without losing hardness, toughness and burnishing.

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quality. It is interesting to note that the solid contents of wood lacquers here are much higher than in U.S.

The use of hot lacquer plants has spread very rapidly indeed during the past few years and it is probably true to say that at least 50 per cent. of the furniture produced today is finished with hot lacquer. This has been partly due to the great improvement in the number, type and design of hot lacquer plants available. It is also due of course, to the urgent desire of furniture manufacturers to apply the requisite quantity of lacquer in the minimum possible time.

Contrary to popular opinion there is no essential difference between hot lacquer and cold lacquer and any good quality cold lacquer could be applied with benefit through a hot lacquer plant. The heating of the lacquer of course, makes it possible to increase the solid content and still retain sprayability.

The main types of hot lacquer plant are as follows:

1. Those based on electrically heated water as the heating medium as in the A.I.D. and Atlas Diesel plants.
2. Those based on metal to metal electric heating of the lacquer line as in the Bede plant. The lacquer coil is set in an aluminium alloy block which is heated electrically.
3. Those based on air as the heating medium as in the Aerograph-De Vilbiss hot lacquer plant.
4. Those based on the steam heating of water as in the Vital plant.
5. Those based on the use of superheated steam both as a propellant and heating medium for the lacquer. This method has been patented by Du Pont of the United States, and is not used in Great Britain. The principle is sound, but demands a superheater in the circuit and special spray guns with a shield and steam trap. The main advantage claimed for this type of hot lacquer plant is that superheated steam as a source of both heat and atomisation of the lacquer is cheaper than the combined cost of compressed air and heating by other methods.

Once the last coat of lacquer is applied and sufficiently hardened by air drying, forced drying or low temperature stoving, the final levelling process is performed. In Great Britain almost invariably, pullover, body-up or levelling solution is used, to shorten the time of the last operations. Pullover solution is, in essence, a diluted nitro-cellulose solvent. It contains approximately 20 per cent. to 25 per cent. of actual nitro-cellulose solvent, together with diluents such as alcohol, hydro-carbons and petroleum ether.

Used in a french polisher's pad, this slow solvent mixture levels off spray ripple and pushes the lacquer into the open grain, if present. The pad is worked in circles or figure of eight, and then finished off in straight lines parallel to the grain. In many cases the furniture is left finished from the pullover with a finish equal to a french polish "stiff up." The process is much easier than with shellac and the necessary skill can be acquired in days as against years for french polishing. Indeed the speed of pulling over has been the main factor which has converted the bulk of the furniture trade in this country from french polish to cellulose finishing.

Curiously enough pullover is rarely used in the U.S.A. This is because it is largely unknown. Where it is known, there is the deliberate policy of eliminating individual skill and hand processes by machine finishing. This means that in the United States sufficient lacquer is applied to fill the grain of the wood without having to shift it into the grain by pullover. The last application of lacquer therefore is followed by machine sanding, using white spirit or soap and water as a lubricant, followed by machine burnishing with coarse and fine abrasive polishes.

In England even when the final finish is machine burnished, pullover is used as an intermediate operation because it shortens the time of burnishing and economises in lacquer. The polishing compounds are usually paste or semi-liquid emulsions of light mineral oil and pine oil with kieselguhr and proprietary emulsifying agents, such as napthalene sulphonates, alkali ricinoliates, amine soaps, etc.

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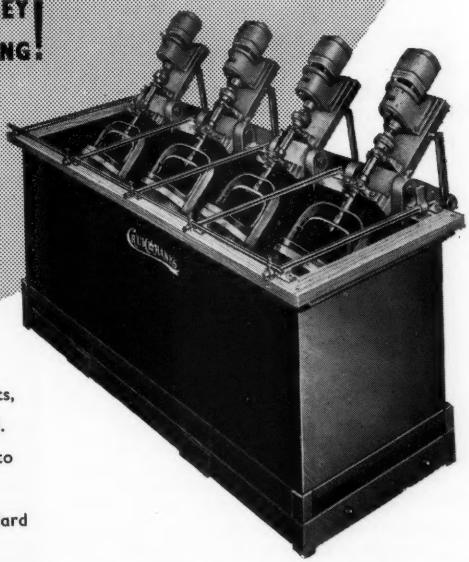

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The above procedure in the main covers the average process required to give a bright finish on wood by modern methods. On some classes of furniture however, matt and semi-matt finishes are very popular. This applies to reproduction types and high class furniture where a wax type finish is required. The matting agent used more than any others in this country is zinc stearate, but other metallic soaps, china clay or silica gel dispersions can be used. For a high class matt finish the full process described above may be gone through and then the final brightness dulled with a mist coat made up of one part matt lacquer, and three part of cellulose thinners. A cheaper matt finish can be obtained by applying one or two coats of matt lacquer directly over the spray colour.

For pigmented enamel finishes on wood, procedure is much simpler and more straightforward. The article to be finished is primed or primer filled and then finished with one, two or three coats of pigmented enamel. The bulk of enamelled finishes on wood are cellulose based, but there have been some inroads into this field by styrenated alkyds and other rapid hardening resins.

We can, perhaps, conclude this very brief survey of modern wood finishing practice by an indication of the main defects, which are liable to occur in mass production wood finish.

1. *White in the grain.* This can be caused by spraying sealer or finishing coats over incompletely dried oil filler. White spirit, high flash naphtha, hydro-carbons, will tend to precipitate nitro-cotton or shellac in the sealer coat. This will obviously be more acute where the filler is thickest, i.e., in the grain of the veneer.
2. *Pinholing.* This is caused by too rapid hardening of the lacquer with solvent still present. This defect is accentuated by too high a temperature, or too thick a coat of lacquer, or both. Surface hardening occurs, solvent is trapped and blows pinholes in the finish as it finally escapes. The pinholing always occurs in the last few minutes of the setting time of the lacquer. When it occurs the defect is always worst on flat horizontal surfaces, where the lacquer is thickest, and the solvent evaporates in a vertical plane. High bodied lacquers and hot lacquers, based on low viscosity cotton, are naturally more prone to this defect due to the thickness of coat applied in one spray application. The immediate remedy lies in, (a) applying a thinner coat of lacquer, (b) thinning down the lacquer or (c) adding medium to high boiling solvent to retard the speed of evaporation of the lacquer.
3. *Orange peel or spray ripple.* More time is lost through this defect than through all other factors put together. Whenever possible, it is strongly advisable to paper down or level up with pullover solution between coats of lacquer. The same factor which causes pinholing will accentuate spray ripple. If the lacquer is too rapid drying, is not sufficiently atomised during spraying, or has not sufficient intrinsic flow, then high boiling solvent added as a retarder will help to cure this complaint.
4. *Blushing.* In an excessively humid and cold atmosphere this characteristic milky bluish-white bloom may occur during the drying process. It is thermodynamic in origin. Energy is lost during the rapid expansion and evaporation of solvents against atmospheric pressure. The wet lacquer film is cooled and moisture from the humid atmosphere condenses on the surface. Nitro-cotton or resin, or both are precipitated by the moisture, and cause the blush. The remedy is to increase butyl alcohol content and thus slow the drying. This prevents the rapid loss of energy and furthermore the butyl alcohol will absorb 2 per cent. or 3 per cent. of water without turbidity.
5. *After bloom.* This occurs as a grape-like bloom on the lacquer after it is hard and dry and can be wiped off with a soft cloth.

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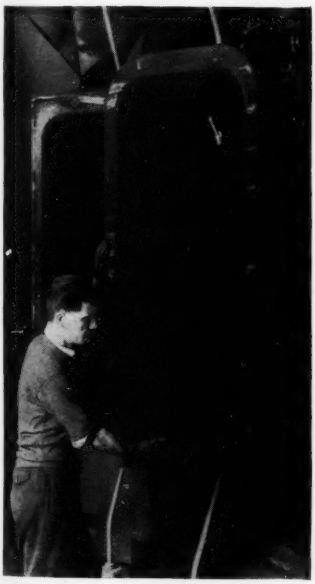

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Apparently this bloom can appear again and again even after wiping off, particularly in a cold, humid atmosphere. The exact cause of the bloom is still subject to inspired guessing, but certain things have been established. Firstly; any cellulose lacquer containing ester gum or rosin in appreciable quantities is liable to bloom. Secondly; cellulose lacquers containing synthetic resins which are rosin modified are liable to bloom. Thirdly; cellulose lacquers based on nitro-cellulose-synthetic resins which are free of rosin or ester gum, are sometimes free of bloom.

There are many other minor complaints which will occur in modern spray finishing of wood and it is remarkable how this section of industrial finishing gives more trouble than all the rest put together. Each one has to be examined carefully on its merits and its case history investigated.

In general, it can be stated that there are substantial attempts on a large scale to break into the cellulose monopoly in wood finishing, but the convenience and flexibility of cellulose makes it very difficult to displace. Failing the universal use of forced drying methods, there is no doubt that it will hold its own for some years to come.

SCOTTISH DESIGN CONGRESS

ON 26th and 27th May, the Council of Industrial Design, Scottish Committee, is holding its third major event; a Scottish Design Congress in the Assembly Rooms, Edinburgh, which, it is anticipated, will attract attention far beyond the confines of Scotland.

Lord Home, the Minister of State for Scotland, will open the Congress, and thereby underline the importance attached to the proceedings by the Government and the Scottish Office. The theme of the Congress will be the promotion of design as a high-level responsibility in industry, commerce and the public services, and a very distinguished panel of speakers will be presented. Those who have already agreed to give papers are shown below, and other invitations are still under consideration.

Sir Colin Anderson, director, Anderson, Green and Co. Ltd. Former president, Chamber of Shipping of the United Kingdom.

Sir Thomas Barlow, chairman, Barlow and Jones Ltd. Former chairman, Council of Industrial Design.

Mr. Misha Black, director, Design Research Unit.

Mr. D. C. Butlin, Director of Public Relations, the National Cash Register Co. Ltd.

Mr. T. C. Coughtrie, chairman, the Belmos Co. Ltd.

Mr. R. Llewelyn Davies, director, Division for Architectural Studies, the Nuffield Foundation.

Mr. Sebastian Earl, managing director, Selfridges Ltd.

Mr. Ashley Havinden, director, W. S. Crawford Ltd. President, Society of Industrial Artists.

Mr. R. T. Laughton, chairman, the Royal Hotel, Scarborough, and the Loch Maree Hotel, Inverness.

Sir John Maud, Permanent Secretary to the Ministry of Fuel and Power.

Sir Walter Puckey, president of the Institution of Production Engineers.

Mr. Elias Svedberg, Chief Architect and Designer, Nordiska Kompaniet, Stockholm.

Mr. W. T. C. Walker, deputy county architect for the West Riding of Yorkshire.

Mr. H. G. Wonnacott, director, Associated Merchandising Corporation.

This is a Congress at which it is hoped to bring together leading figures from every sphere throughout Scotland who have the opportunity to influence design in one way or another—and who has not?—manufacturers, wholesalers, retailers, public services and local authorities. It is primarily a Scottish Congress, but speakers have been drawn from a wide field and it is hoped to have representatives from organisations particularly interested in industrial design from other parts of the United Kingdom, and also from abroad. An exhibition illustrating development in design during recent years, and a selection of current products of outstanding design will form a background to the papers and discussions.

Delegates will be entertained by the City of Edinburgh at the City Hall on the evening of the 26th, and there will be a formal dinner to close the Congress on the evening of the 27th. Further details are available from the C.O.I.D., Scottish Committee, 95 Boswell Street, Glasgow, C.2.

Modern Industrial Ventilation and Oven Co. Ltd. inform us that on 29th March they moved to larger premises at C.M.L. Buildings, Great Charles Street, Birmingham 3. The telephone number is now Central 2531.

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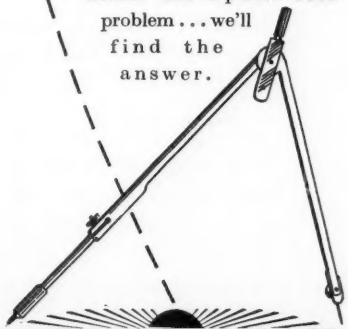

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In addition, the editorial staff of INDUSTRIAL FINISHING *are always available as an advisory service on questions affecting finishing.*

Chemical Black Finish. Illustrated brochure gives details of chemical blackening process operated by a Midland firm. It is claimed to give a richer and "blacker" finish in a five-minute cycle than is usual in such processes. Tool Treatments Ltd., Colliery Road, Birmingham Road, West Bromwich, Staffs. (47)

Water Removal and Anti-rust Treatment. A simple treatment, claimed to displace water and prevent corrosion, is described in a two-colour folder. The details given include particulars of how the system works and the plant offered by the makers. Tool Treatment Ltd., Colliery Road, Birmingham Road, West Bromwich, Staffs. (48)

Safety Type Overhead Radiant Heaters. Illustrated pamphlet describes a wedge safety type of overhead radiant gas heater suitable for use wherever there is risk of inflammable vapour. A booklet gives details of this and other types of radiant gas heater. Bratt Colbran Ltd., Lancelot Works, Wembley, Middx. ((49)

Paint Rejuvenator. A two-colour brochure deals with a paint rejuvenator claimed to restore condition of a long-stored paint in a matter of minutes. It handles cans from one pint to one gallon in size. Steele and Cowlishaw Ltd., Cooper Street, Hanley, Stoke-on-Trent. (50)

Protective Masks. In a coloured pamphlet details are given of two types of filter pad protective masks—one for normal industrial conditions, the other for conditions with strong fire hazard. Description is also given of a dust respirator with a rubber mouthpiece. Martindale Electric Co. Ltd., Westmorland Road, N.W.9. (51)

Electric Sprayer. Pamphlet gives illustrated description of a new electric sprayer. Gun is of bleed type with con-

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stant air flow. Continuous air supply is possible without the use of a receiver. Three nozzles give round spray, fan-shaped spray and angle fan spray. Martindale Electric Co. Ltd., Westmorland Road, London, N.W.9. (52)

Mechanical Continuous Loader. Giving a continuous flow of loose materials at between 30 and 50 cu. yds. an hour, the loader described in this brochure can be operated by one man and is easily manœuvrable. Illustrations are given of its use with different conveyors. David Roberts and Co. Ltd., 276 Monument Road, Birmingham 16. (53)

Electronic Temperature Controller. An illustrated sheet explains scope and applications of electronic temperature controller. A broken thermocouple device is an inherent feature of this instrument which is designed for instant servicing by plant personnel without recourse being necessary to specialised technical knowledge of the equipment. Kelvin Hughes (Industrial) Ltd., 2 Caxton Street, S.W.1. (54)

Silicone Fluids. Attractive booklet gives clear information on the properties and uses and chemical structure. Recommendations it contains are based on both laboratory and field investigations. Midland Silicones Ltd., 19 Upper Brook Street, W.1. (55)

Furnace Safety Systems. System giving immediate cut-off in the case of flame failure of oil- or gas-burning equipment is described in an illustrated brochure. Viewing head embodies an infra-red sensitive cell connected to the control unit which responds only to modulated signals from the viewing head. Industrial Electronic Engineers, 10 Wyndam Place, W.1. (56)

Silastomer. A booklet giving the essential facts about Silastomer—a range of silicone rubbers—and accounts of the ways in which its properties can be used to provide a resilient rubbery material under conditions where neither natural nor organic synthetic rubbers can be used. Midland Silicones Ltd., 19 Upper Brook Street, W.1. (57)

Dewatering Oil. Description of a dewatering oil compounded of mixture of a soft grease-like material serving as a temporary anti-corrosive film former. Special additives with dewatering properties and a volatile diluent are included. Data sheets give application methods and analysis. Croda Ltd., Croda House, Snaith, Goole, Yorks. (58)

(*Continued on page* 678.)

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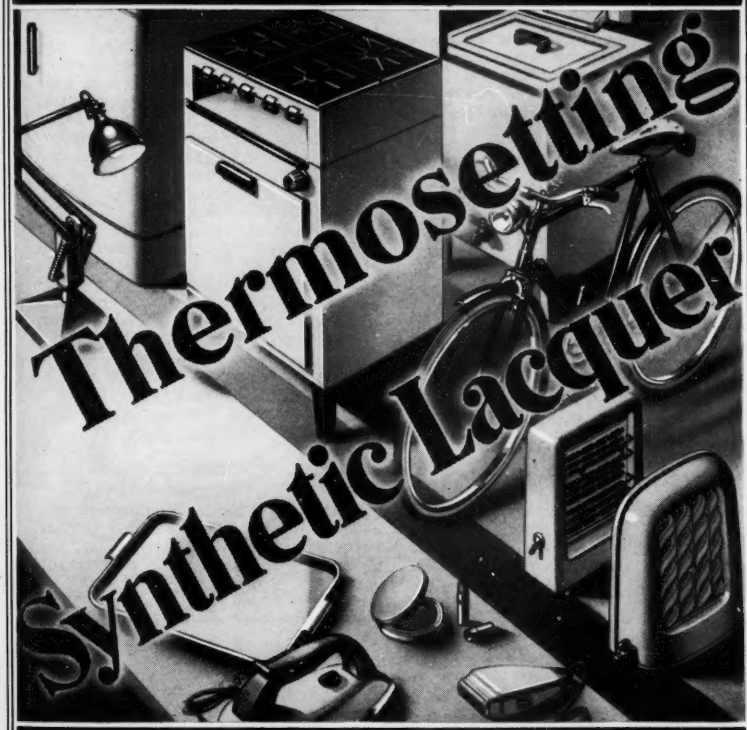

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Surface Preparation. Pamphlets describe the surface preparation for repainting using pumice block. The Utility Chemical Co., Bromley, Kent. (59)

Graining Papers. A booklet gives information on a number of different patterns of graining papers, together with directions for use. The Utility Chemical Co., Bromley, Kent. (60)

High-temperature Electric Furnaces. Two-colour data booklet with diagrams, illustrations and technical information on molybdenum-wound, high-temperature furnaces and their uses. Royce Electrical Furnaces Ltd., Walton-on-Thames, Surrey. (61)

Control and Recovery of Dust and Fume in Industry. A reprint of a paper given to the Institution of Mechanical Engineers on this problem. The Power-Gas Corporation Ltd., Stockton-on-Tees and London. (62)

Mica Powders. The applications and properties of mica powders are illustrated in a booklet. This versatile powder has an interesting use in producing fancy goods and decorations with an artificial frosted finish. Micafine Ltd., Derby. (63)

Electrodeposition. A brochure describes a new process of electrodeposition. Metachemical Processes Ltd., 13 Stratford Road, Acton, W.3. (64)

Rust and Corrosion Remover. In an illustrated booklet an electro-chemical process for removing rust, corrosion and other extraneous surface deposits from metal is described. Derustit Ltd., 47 Victoria Street, S.W.1. (65)

Portable Blowers. A number of different types of blower is described in a brochure, as well as details of heater units for attachment. Martindale Electric Co. Ltd., Westmorland Road, N.W.9. (66)

NAMES IN THE NEWS

Appointments

In accordance with developments envisaged at the time of the formation of Telcon Telecommunications Ltd., owned jointly by Mullard Ltd. and the Telegraph Construction and Maintenance Co. Ltd., **Mr. J. Innes, C.B.,** a director of the latter company, has relinquished the managing directorship and his directorship of Telcon Telecommunications Ltd., but will continue to act as consultant to the Board. **Mr. C. L. G. Fairfield, M.A., M.I.E.E., A.M.I.Mech.E., Barrister-at-Law,** Telcon's general sales manager, has been appointed a director as one of the three Telcon representatives on the Board. **Mr. W. Sampson, B.A., A.M.I.E.E.,** has been appointed executive director and will take over Mr. Innes' managerial duties. Mr. E. H. Gosling, A.S.M.A., previously home sales manager of Telcon's Cables Division, has been appointed home sales manager for cables, plastics and engineering products.

Mr. J. C. Howard, a director of Electric Furnace Co. Ltd., has been made a director of EFCO Engineering Co. Ltd.

Electrostatic Flocking Equipment.—We understand that Alfred Jacoby, 9 Acol Court, Acol Road, N.W.6, is in a position to supply equipment for electrostatic flocking.

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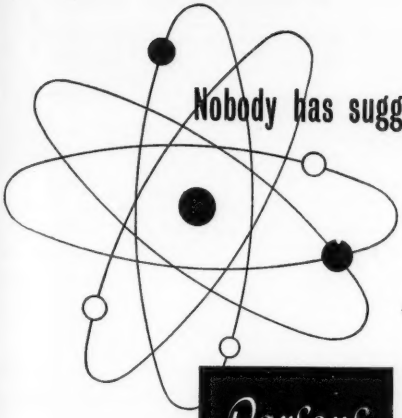

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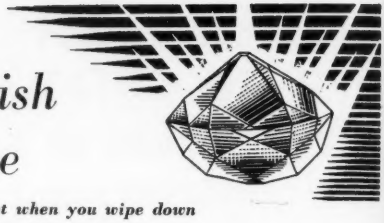

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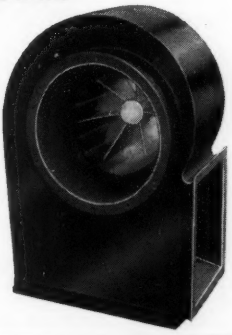

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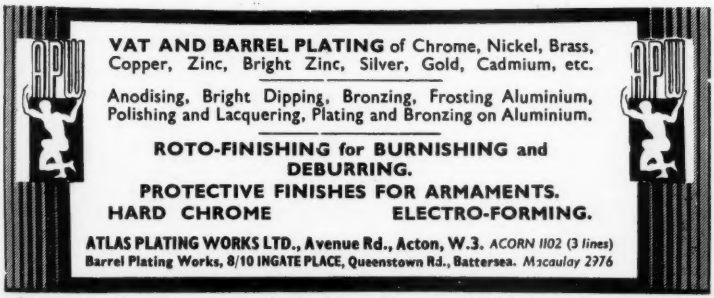
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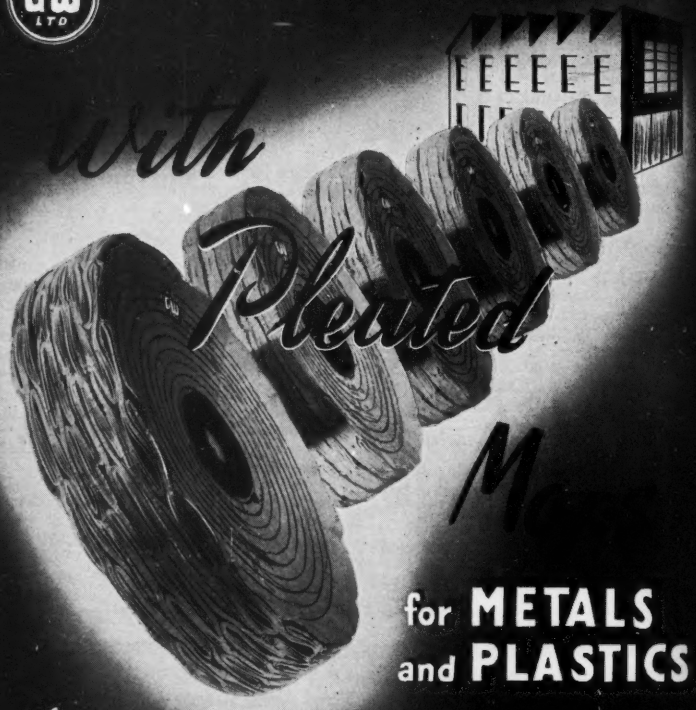

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